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FRDA REPORT 124

AN ECONOMIC STRATEGY FOR MANAGING ASPEN ON PRIVATE LANDS IN NORTHEAST BRITISH COLUMBIA

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FOREST RESOURCE DEVELOPMENT AGREEMENT

Canada

BC

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INTRODUCTION

Over the past several years the utilization of aspen has increased dramatically in northwestern Alberta and more recently in northeast British Columbia. A large portion of the resource in B.C. is located on private land and much of this land is marginal for agriculture.

This report provides and discusses some of the basic information necessary to consider the management of aspen on private land as a crop that would provide diversification where agriculture is marginal.

More and better information, both on the forest management side and on the marketing and utilization side, will be necessary as interest in and use of the resource increases. When more manufacturing is developed at various locations in the region, greater market opportunities will develop for aspen from private land in terms of both different locations for sales and different aspen timber products/specifications to harvest.

1. INVENTORY

CURRENT STATUS

Recent inventory for the Dawson Creek - Fort St. John area of B.C. to denote the hardwood resource is not available

Currently, new inventory estimates are in progress but complete coverage cannot be expected for some time. The Ministry of Forests recognizes this need and has stated (MOF 1988) that a reinventory of the area will be necessary to manage the deciduous resource.

Concern has also been expressed that the inventory must accurately determine the age of the stands, as evidence suggests aspen deterioration is strongly correlated with age. This has serious management implications, particularly if peak quality occurs before culmination.

Inventory data analyzed for this report supports the premise that deterioration in quality can occur at an earlier age than might be expected as stand volumes on known areas are declining as age increases from age class 5 to age class 6 (i.e. from 81 - 100 years to 101 - 120 years). If volume is being lost by this time, the quality of the stand must have deteriorated at a significantly earlier age.

An important management question that arises from the above is that even-flow harvesting may not be appropriate if large mature volumes are available that could be lost if not harvested promptly. If prompt harvesting does not occur, salvage and/or rehabilitation may be necessary in order to assure the future of the resource.

ESTIMATING PROCEDURES

Several problems exist in estimating the size and characteristics of the aspen resource for the purposes of this report. Foremost are the lack of current inventory and the focus on aspen with particular reference to private land. Any estimates derived are subject to several factors that beg quantification such as Crown ownership becoming private, clearing forest land for agriculture, recognizing immature aspen as private productive forest as opposed to brush or a non-commercial designation, or aspen grass pasture land, etc.

For the purposes of this report, interim estimates were formulated, with the intent of providing a general order of magnitude until such time as more precise inventory and agriculture-forestry relationships can be used to provide more definite estimates. The approach taken was to analyze the largest current set of inventory data available as to selected major characteristics only, and compare this to the same set

and characteristics of the older 1970 inventory (See Appendix 1). Given a large enough sample covering a large variety of characteristics, this information should have some validity (albeit low) in predicting changes in adjacent or surrounding areas.

The area cross-hatched on the map in Appendix 1 was used to establish the relationships between the 1988 inventory and the 1970 inventory. These relationships were then used in conjunction with the 1970 inventory to provide estimates for the three areas shown in Figures 2, 3 and 4. Figure 1 shows an estimate that is based almost entirely on the 1988 sample. Sample size was approximately 350,000 hectares, and this was used in predicting estimates for a further 684,000 hectares to the west and north of the sample area using the 1970 inventory data for the areas as a base.

INTERIM ESTIMATES

Table 1 and Figure 1 show the timber supply on an estimated inventory basis for a supply area with Dawson Creek as the focal point. Note that (as with the other areas reported) the basis for reporting focus on aspen. The volumes shown for aspen include all age classes and any stand having 20 percent or more aspen.

Other species components of the stand, including other hardwoods as well as conifers, is shown in the next column. While this procedure "masks" somewhat the more or less pure stands of aspen with respect to Crown land, it gives a clear picture of the total resource on private lands, and an indication of the degree to which aspen dominates.

The Dawson Creek estimates reflect the agricultural setting of this supply area. The majority of the resource is in private ownership and stands with aspen generally have significantly more aspen that other species.

Estimates for the Chetwynd area to the west are shown in Table 2 and the area covered in Figure 2. This area has a predominance of Crown land and stands with aspen have a significant component of other species, particularly on Crown land.

Farther north in the Hudson Hope - West Fort St. John area (Table 3 and Figure 3) the same trend is evident. This area has a slightly higher proportion of private land and this land has a slightly higher proportion of aspen.

Estimates for the Fort St. John area north of the Peace River are shown in Table 4 and the area covered in Figure 4. This area has more private land but not as high a proportion as in the Dawson Creek area. Also, about 90 percent of the private land is classed as immature. As with the other areas, the Crown land has a high proportion of other species in stands having an aspen component.

Table 1. Estimated Aspen Timber Supply Tributary to Dawson Creek, B.C.[1]

Ownership	Number of Hectares	Volume (000 m3) Aspen Only	Other Species Component	Total All Species
Crown Managed Lands				
Immature[2]	41,906	1,397	701	2,098
Mature	32,380	3,440	3,059	6,499
Total	74,286	4,837	3,760	8,597
Private Lands				
Immature[2]	57,866	2,768	835	3,603
Mature	27,487	3,696	1,384	5,080
Total	85,353	6,464	2,219	8,683

1. An area with Dawson Creek, B.C. as more or less the central location bounded as follows:

   On the east by Alberta
   On the north by the Peace River
   On the west by Groundbirch
   On the southwest by Oetata Ridge
   On the south by just below Tupper, or Peavine Lake.

   This configuration includes nearly all of the private land in the area that is less than 50 km from Dawson Creek.

2. Less than 80 years old.

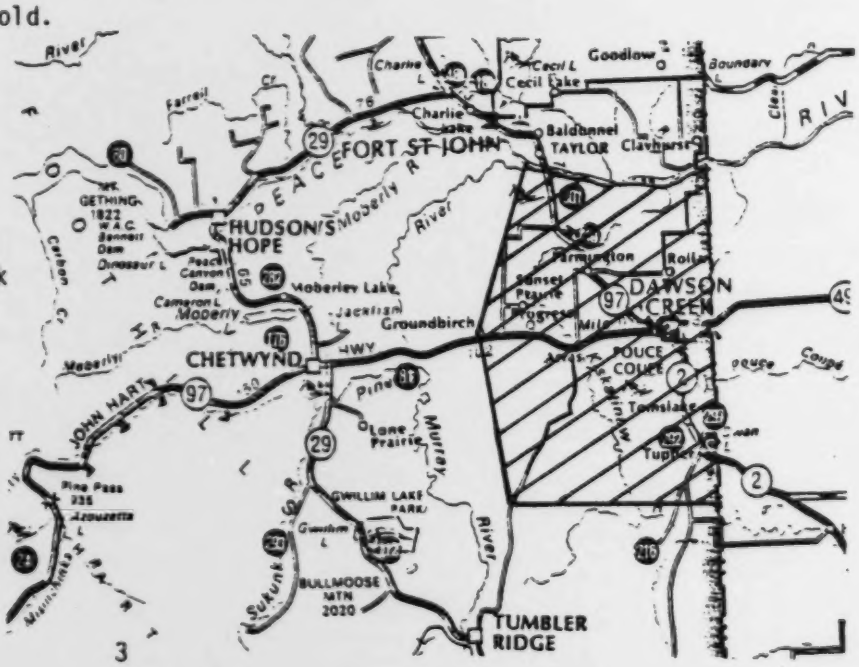


Figure 1.

Aspen Timber Supply Area Tributary to Dawson Creek

Table 2. Estimated Aspen Timber Supply Moberly Lake, Chetwynd and Lone Prairie[1]

Ownership	Number of Hectares	Volume (000 m3) Aspen Only	Other Species Component	Total All Species
Crown Managed Lands				
Immature[2]	99,363	4,510	2,824	7,334
Mature	72,597	9,277	8,696	17,973
Total	171,960	13,787	11,520	25,307
Private Lands				
Immature[2]	10,468	549	355	904
Mature	3,817	611	346	957
Total	14,285	1,160	701	1,861

1. A general area of private and Crown land bounded as follows:

   On the east by Groundbirch
   On the north by the Peace River
   On the northwest by Hudson Hope Municipality
   On the west by Pine Valley
   On the south by Oetco Flats and Gwillam Lake

2. Less than 80 years old.

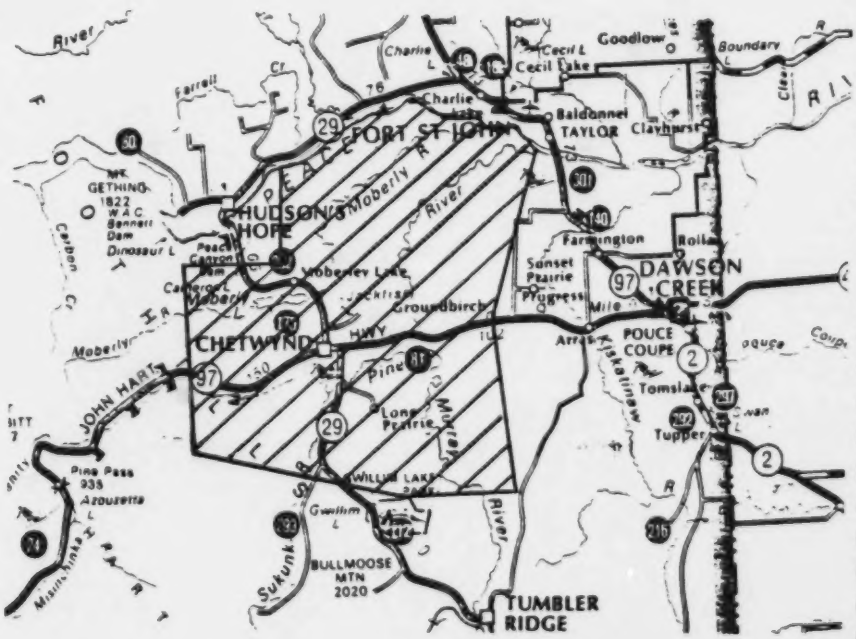


Figure 2.

Aspen Timber Supply Area
Moberly Lake, Chetwynd
and Lone Prairie

Table 3. Estimated Aspen Timber Supply Hudson Hope and West Fort St. John[1]

Ownership	Number of Hectares	Volume (000 m3) Aspen Only	Other Species Component	Total All Species
Crown Managed Lands				
Immature[2]	96,345	5,567	2,077	7,644
Mature	59,054	7,573	7,614	15,187
Total	155,399	13,140	9,691	22,831
Private Lands				
Immature[2]	21,074	1,096	331	1,427
Mature	3,170	572	189	761
Total	24,244	1,668	520	2,188

1. A general area of Crown and private land from Williston Lake and Hudson Hope, north of the Peace River to Bear Flat and Red Creek bounded as follows:

   On the east by Red Creek
   On the northeast by the Alaska Highway
   On the north by Wonowon
   On the west by the headwaters of Groundbirch and Farrell Creeks
   On the south by Hudson Hope Municipality (south boundary)

2. Less than 80 years old.

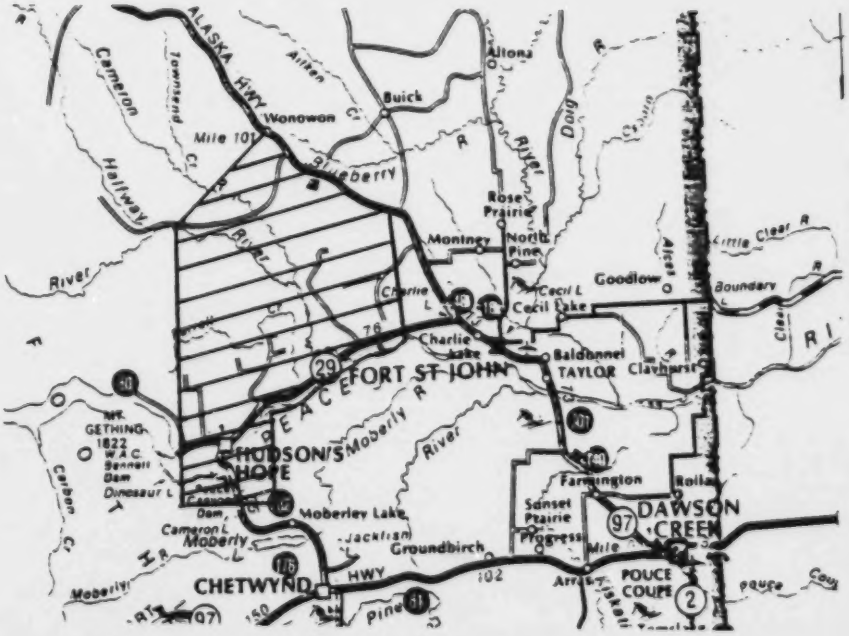


Figure 3.

Aspen Timber Supply
Hudson Hope and
West Fort St. John

Table 4. Estimated Aspen Timber Supply Fort St. John Area North of the Peace River[1]

Ownership	Number of Hectares	Volume (000 m3) Aspen Only	Other Species Component	Total All Species
Crown Managed Lands				
Immature[2]	141,962	3,729	1,639	5,368
Mature	44,435	4,232	5,429	9,661
Total	186,397	7,961	7,068	15,029
Private Lands				
Immature[2]	120,420	2,931	958	3,889
Mature	11,554	1,312	583	1,895
Total	131,974	4,243	1,541	5,784

1. An area with Fort St. John as a south central location bounded as follows:

   On the east by the Alberta border
   On the northeast by the upper Osborn River
   On the north by Altona
   On the northwest by Wonowon
   On the west by Red Creek
   On the south by the Peace River

   This configuration includes nearly all the private land in the area that is less than 75 km from Fort St. John.

2. Less than 80 years old.

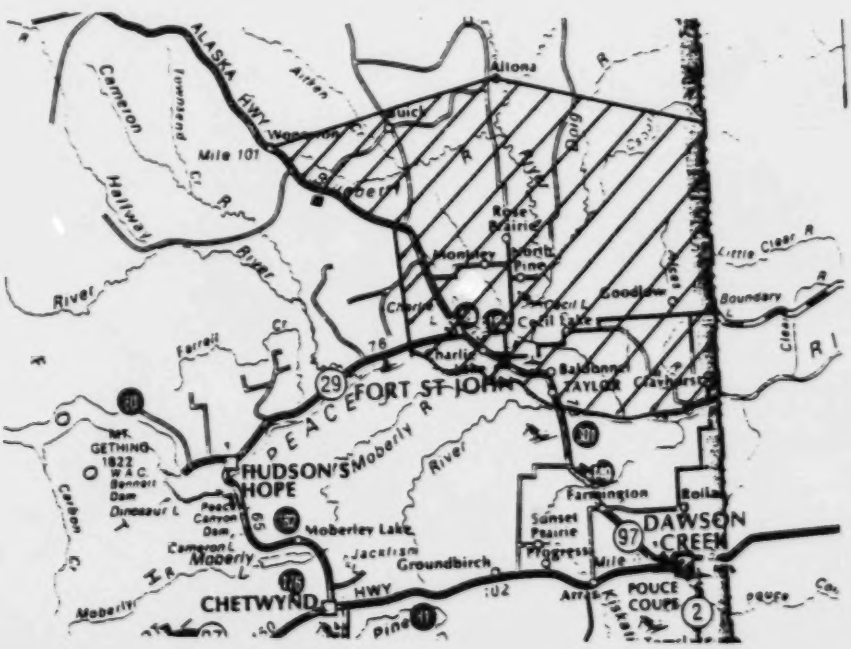


Figure 4.

Aspen Timber Supply
Fort St. John Area
North of the Peace R.

A summary for the four previous described areas is shown in Table 5 for the area shown in Figure 5. This represents a timber supply area that is considerably smaller than the Dawson Creek and Fort St. John Timber Supply Areas, but one that is readily accessible to firms manufacturing aspen products in the region who would locate at central points where transportation and labour, etc., were readily available.

The area has about 256,000 hectares of private land stocked with aspen and component species. Currently, about 6 million m3 of mature aspen are located on some 46,000 hectares of private land along with about 2.5 million m3 of component species. If it can be determined that these mature stands are liable to deterioration, some effort to encourage fast utilization might be appropriate.

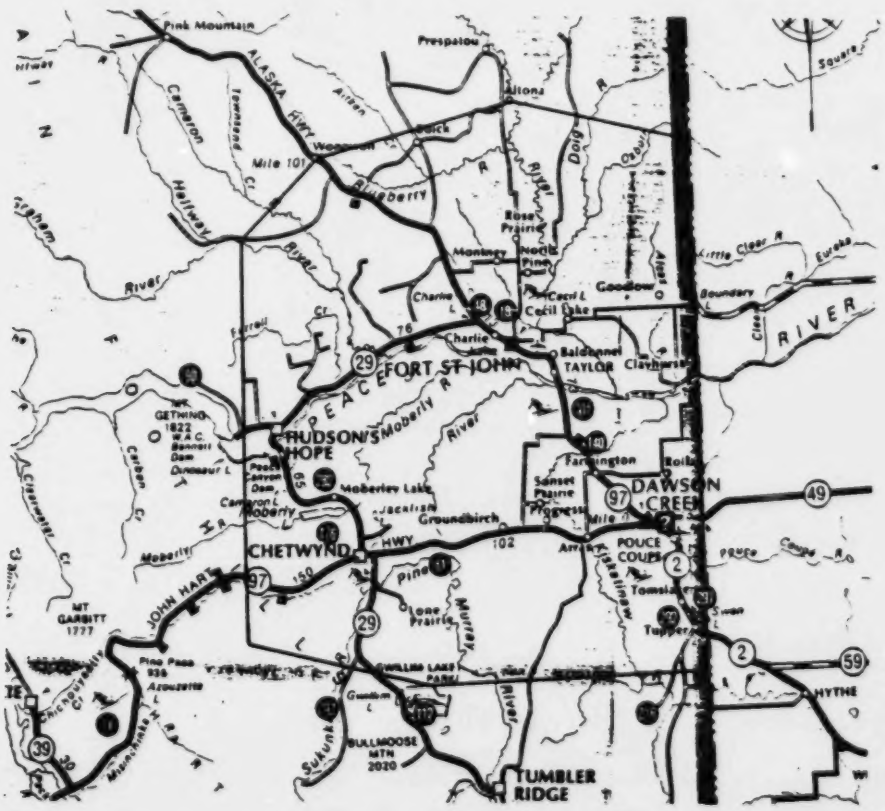
In the long term, depending on farming opportunities or the movement of forest land into or out of agriculture, the 256,000 hectares has a significant potential for growing aspen as a crop. Based on sample data from the forest inventory, the average sight quality of this land falls just below medium. On the basis of the yields discussed in Section 2, the mean annual increment (net) would, on the average, be about 3 m3 per hectare per year at or near culmination. This would indicate a long term potential for an annual harvest of some 768,000 m3. With any degree of forest management including slightly shorter rotations and prompt regeneration, a somewhat higher annual harvest of about 850,000 m3 would be entirely possible.

Table 5. Estimated Aspen Timber Supply in the Dawson Creek, Chetwynd, Hudson Hope and Fort St. John Areas of B.C.[1]

Ownership	Number of Hectares	Volume (000 m3) Aspen Only	Other Species Component	Total All Species
Crown Managed Lands				
Immature	379,576	15,203	7,241	22,444
Mature	208,466	24,522	24,798	49,320
Total	588,042	39,725	32,039	71,764
Private Lands				
Immature	209,828	7,344	2,479	9,823
Mature	46,028	6,191	2,502	8,693
Total	255,856	13,535	4,981	18,516

1. The area in total for the four component supply areas shown previously. The outer boundary of the (four) areas are shown on the following map.

Figure 5. Aspen Timber Supply, Dawson Creek, Chetwynd, Hudson Hope and Fort St. John Areas



2. GROWTH AND YIELD ESTIMATES FOR NORTHEASTERN B.C.

Any strategy for managing aspen on private land would require growth and yield estimates. They are necessary to evaluate the feasibility of timber production, to assess different management alternatives and to support silvicultural decisions.

This section provides estimates for both pure aspen stands and for mixed stands of aspen and spruce on the basis of four site-quality classes. As very limited data are available on the growth and yield of these forest types in northeastern B.C., data from Alberta were used in conjunction with B.C. inventory data to provide the necessary estimates.

ESTIMATES FOR PURE ASPEN

In the general vicinity of northeastern British Columbia, the most comprehensive growth and yield data for pure aspen stands is that compiled by MacLeod (1952). His sampling took place in the Whitecourt-Lesser Slave Lake region of Alberta, about 350 km east of Dawson Creek. On 89 sample plots, average species composition was 93.9% aspen, 5.2% balsam poplar and 0.9% birch - a stand make-up similar to that on private lands in northeastern British Columbia. MacLeod's sampling involved even-aged stands between 10 and 140 years of age.

Although the normal yield tables developed by MacLeod are strictly applicable only to the area sampled, he considered them to be applicable to the Grande Prairie-Peace River region, which in biogeoclimatic terms is indistinguishable from the Dawson Creek-Fort St. John agricultural area. Gross and net yields in cubic meters per hectare are listed in Table 6 for pure aspen stands 30 to 120 years of age and for four site quality classes. Correction factors used to convert gross volume to net volume are summarized in Table 7.

Table 6. Gross and net yields (m3/ha) for pure aspen stands, excluding bark, for all trees over 1.5 cm dbh gross, on four site quality classes

TOTAL AGE	SITE QUALITY CLASS							
	POOR		FAIR		MEDIUM		GOOD	
	50		60		70		80[a]	
	(11.9)		(14.3)		(17.1)		(19.5)[b]	
	Gross	Net[c]	Gross	Net	Gross	Net	Gross	Net
30	80	0	104	10	132	26	162	40
40	112	8	142	37	180	81	220	112
50	138	63	174	97	218	144	266	202
60	159	105	200	148	249	204	304	258
70	177	135	223	181	275	239	335	298
80	191	159	241	205	297	261	361	325
90	204	177	256	225	316	281	382	344
100	213	190	266	237	331	298	399	355
110	222	200	274	247	343	309	413	368
120	228	205	282	254	352	313	426	375

a. Site index as defined by MacLeod 1952: 50 = height (ft) of average dominant aspen at age 80; 80 = 80 feet tall at age 80.

b. Site index expressed as height of average dominant aspen, metres, at age 50.

c. See Table 7 for correction factors to convert gross volume of entire stem to net volume for 15 cm stump and 10 cm top.

SOURCE: MacLeod, 1952

Table 7. Correction factors (in percent) to convert aspen gross volume of entire stem (excluding bark) to net volume for 15 cm stump and 10 cm top

Site Quality Class	AGE										
	20	30	40	50	60	70	80	90	100	110	120
Poor (11.9)[a]	0	0	7	46	66	76	83	87	89	90	90
Fair (14.3)	0	10	26	56	74	81	85	88	89	90	90
Medium (17.1)	0	20	45	66	82	87	88	89	90	90	89
Good (19.5)	0	25	51	76	85	89	90	90	89	89	88

a. Figures in brackets are metric conversions of site index as defined by MacLeod (1952), where 11.9 refers to height of average dominant, metres, at age 50.

SOURCE: Calculated by Nawitka Consultants using relationships and destructive sampling information from Woodbridge, Reed and Associates Ltd. (1985), B.C. Research (1983) and MacLeod and Blyth (1955).

To check the validity of using the Alberta yield tables for the Dawson Creek - Fort St. John region, MacLeod's yield figures were compared with inventory data gathered by the Ministry of Forests in northeastern British Columbia. These comparisons are summarized in Table 8 for poor and medium sites. MOF poor site yields between ages 30 and 110 were very close to the predicted yields if one averaged MacLeod's poor and fair sites (site indices of 11.9 m and 14.3 m at 50 years, respectively).

For the mean of these two site classes, MacLeod's yields ranged from 92% to 103% of MOF yields for the five stand ages shown in Table 8. For MacLeod's medium site (site index 17.1 m at 50 years) predicted yields ranged from 89% to 102% of MOF yields at ages 50, 70, 90 and 110. At age 30 there was a substantial difference between the two data sources.

Table 8. Comparison of yields (m^3/ha) based on MOF Inventory Data from northeastern British Columbia and Alberta data assembled by MacLeod (1952)

	Poor site yields (m^3/ha)				Medium site yields (m^3/ha)			
	MOF	MacLeod			MOF	MacLeod		
Age (yrs)	Invent (11-14 m)[b]	(50)[a] (11.9 m)[c]	(60) (14.3 m)	(mean)	Invent (15-21 m)	(60) (14.3 m)	(70) (17.1 m)	(80) (19.5 m)
30	5 (27)[d]	0	10	5	15 (27)	10	26	40
50	87 (39)	63	97	80	140 (44)	97	144	202
70	153 (41)	135	181	158	249 (40)	181	239	298
90	196 (26)	177	225	201	288 (37)	225	281	344
110	235 (14)	200	247	223	347 (22)	247	309	367

a. Site index as defined by MacLeod (1952): 50 = height (ft) of average dominant aspen at age 80.

b. Range of site index in MOF sample, expressed as height (m) of average dominant aspen at age 50.

c. MacLeod's site index expressed as height (m) of average dominant aspen at age 50.

d. Sample size in brackets. Samples ranged from less than 10 to over 1000 ha in the age class in a subcompartment where 75% of the volume was aspen.

This difference can be explained by the fact that trees less than 17.5 cm dbh were not considered as merchantable under the limits specified in the MOF Inventory. The MacLeod-based estimates include trees having a dbh between 12.5 cm and 17.5 cm; the MOF estimates do not.

The yield differences shown in Table 8 for ages 50 years or better are considered to be small in comparison to the variation in site indices covered. For this reason the yield differences shown in Table 8 are considered to be small enough to justify the use of MacLeod's yield estimates (Table 6) for pure aspen stands in the Dawson Creek - Fort St. John region. The four site quality classes listed in Table 6 are considered to cover the range of sites that one could encounter on private lands in the vicinity of Dawson Creek and Fort St. John.

ESTIMATES FOR ASPEN-SPRUCE MIXTURE

For yield estimation on private lands that contain some spruce in mixture with aspen, the most comprehensive nearby sampling is also from the Whitecourt-Lesser Slave Lake area where MacLeod and Blyth (1955) obtained data from 229 sample plots in stands from 25 to 150 years of age. Using that data source, gross and net yields of spruce and of aspen are summarized in Tables 9 to 12 for stands aged 30 to 120 years on poor, fair, medium and good sites. As shown in these yield tables, the total volume and overall proportion of spruce progressively increase as these mixedwood stands develop.

In contrast the volume of aspen tends to peak at about 90 years of age on poor and fair sites and at about 80 years of age on medium and good sites. More aspen is available at an earlier age on poor and fair sites than on medium and good sites. This characteristic has important management implications which will be discussed in more detail under silvicultural strategies for managing spruce-aspen mixedwood stands.

Table 9 Gross and net yields (m3/ha), excluding bark, and relative proportions (%) of spruce and aspen in fully stocked mixedwood

Poor Site - site index = 11.9 m at age 50

Total Age, (for spruce)	SPRUCE			ASPEN			ENTIRE STAND	
	Gross	Net[a]	Prop(%)[b]	Gross	Net[c]	Prop(%)	Gross	Net
30	0	0	1	111	0	99	111	0
40	8	0	13	147	10	87	155	10
50	19	0	21	175	80	79	194	80
60	37	3	28	196	129	72	233	132
70	58	13	34	210	160	66	268	173
80	83	36	38	217	180	62	300	216
90	109	70	42	219	191	58	328	261
100	136	104	46	215	191	54	351	295
110	160	131	50	201	181	50	361	312
120	183	156	55	181	163	45	364	319

a. Net volume as defined by MacLeod and Blyth (1955) for a 0.3 m stump and 10 cm top inside bark.

b. The relative proportions(%) of spruce and aspen are based on basal area comparisons.

c. Net volume based on correction factors shown in Table 7. For example, on a poor site none of the gross stem volume is merchantable at age 30, 7% is merchantable at age 40 and 46% is merchantable at age 50.

SOURCE: MacLeod and Blyth, 1955

Table 10. Gross and net yields (m3/ha), excluding bark, and relative proportions (%) of spruce and aspen

Fair Site - site index = 14.3 m at age 50

Total Age, (for spruce)	SPRUCE			ASPEN			ENTIRE STAND	
	Gross	Net[a]	Prop(%)[b]	Gross	Net[c]	Prop(%)	Gross	Net
30	3	0	8	109	11	92	112	11
40	16	0	21	142	37	79	158	37
50	37	3	31	164	92	69	201	95
60	64	13	38	182	135	62	246	148
70	97	40	43	193	157	57	290	197
80	129	78	47	199	169	53	328	247
90	159	117	50	200	176	50	359	293
100	189	154	53	197	175	47	386	329
110	216	185	57	185	167	43	401	352
120	241	214	62	165	148	38	406	362

a. Net volume as defined by MacLeod and Blyth (1955) for a 0.3 m stump and 10 cm top inside bark.

b. The relative proportions (%) of spruce and aspen are based on basal area comparisons.

c. Net volume based on correction factors shown in Table 7. For example, on a fair site 10% of the gross stem volume is merchantable at age 30, 26% is merchantable at age 40 and 56% is merchantable at age 50.

SOURCE: MacLeod and Blyth, 1955

Table 11. Gross and net yields (m3/ha), excluding bark, and relative proportions (%) of spruce and aspen

Medium site - site index = 17.1 m at age 50

Total Age, (for spruce)	SPRUCE			ASPEN			ENTIRE STAND	
	Gross	Net[a]	Prop(%)[b]	Gross	Net[c]	Prop(%)	Gross	Net
30	7	0	13	106	21	87	113	21
40	28	2	29	132	60	71	160	62
50	62	11	41	149	98	59	211	109
60	101	39	47	164	135	53	265	174
70	142	80	51	174	152	49	316	232
80	183	129	54	181	159	46	364	288
90	220	177	58	181	161	42	401	338
100	254	218	61	175	158	39	429	376
110	283	252	64	165	148	36	448	400
120	310	281	68	149	132	32	459	413

a. Net volume as defined by MacLeod and Blyth (1955) for a 0.3 m stump and 10 cm top inside bark.

b. The relative proportions(%) of spruce and aspen are based on basal area comparisons.

c. Net volume based on correction factors shown in Table 7. For example, on a medium site 20% of the gross stem volume is merchantable at age 30, 45% is merchantable at age 40 and 66% is merchantable at age 50.

SOURCE: MacLeod and Blyth, 1955

Table 12. Gross and net yields (m3/ha), excluding bark, and relative proportions (%) of spruce and aspen

Good site - site index = 19.5 m at age 50

Total Age, (for spruce)	SPRUCE			ASPEN			ENTIRE STAND	
	Gross	Net[a]	Prop(%)[b]	Gross	Net[c]	Prop(%)	Gross	Net
30	11	0	17	103	26	83	114	26
40	43	5	36	123	63	64	166	68
50	90	27	48	134	102	52	224	129
60	141	74	55	143	122	45	284	196
70	192	131	59	150	133	41	342	264
80	241	189	62	153	137	38	394	326
90	284	240	65	150	135	35	434	418
100	319	283	68	145	129	32	464	412
110	350	317	71	136	121	29	486	438
120	376	344	74	123	108	26	499	452

a. Net volume as defined by MacLeod and Blyth (1955) for a 0.3 m stump and 10 cm top inside bark.

b. The relative proportions(%) of spruce and aspen are based on basal area comparisons.

c. Net volume based on correction factors shown in Table 7. For example, on a good site 25% of the gross stem volume is merchantable at age 30, 51% is merchantable at age 40 and 76% is merchantable at age 50.

SOURCE: MacLeod and Blyth, 1955

3. SILVICULTURAL STRATEGIES

SIZE OF HARVEST

The silvicultural strategy is influenced by the size of the woodlot and more particularly by stand age classes (if such exist) within the woodlot. Very small aspen woodlots can be harvested in a few or even one cut while large woodlots are more amenable to being harvested in "patches" depending on the age and size of the "patches" or compartments. As pure aspen is ideally suited to clear-cut harvesting from a management and silvicultural point of view, the size (hectares) of the cut is mostly likely to be limited by other factors or management considerations.

In general, harvesting only a few hectares will incur proportionately higher management and logging cost. On the other hand harvesting very large areas may have some detrimental effects. Wind break effects can be altered and, in some cases, water tables can be affected. Recreation and habitat and aesthetics can be altered. Also, in some cases, risk increases concerning monetary returns as logging must be maintained over a long period and wood purchase agreements as to volume and timing of delivery can be limiting.

For the purpose of this report good coverage for the private land situation in northeastern B.C. can be provided by considering woodlots from 80 acres (32 hectares) to about 1000 acres (400 ha) and harvesting in blocks from 10 acres (4 ha) to 40 acres (16 ha) For woodlots of about 160 acres (65 ha) and larger, harvesting can frequently be planned at short periodic intervals (say every 5 years) such that the woodlot can supply a steady stream of income for an indefinite time period (i.e. sustained yield).

TIMING OF HARVEST - PURE ASPEN

Harvesting can proceed when a stand of timber has a sufficient number of stems of a size that are merchantable. For aspen in the northeast of British Columbia, the net columns in Table 13 denote the merchantable component. This component is for stems that have attained or exceed a dbh of 12.5 cm, which approximates the minimum specifications for pulpwood merchantability. Note in Table 13, for instance, that with medium site a significant volume component becomes merchantable from 50 to 60 years (i.e. 144 m3 to 204 m3) and that the volume in stems not having a merchantable size (largely the difference between the gross and net) declines from 74 m3 to 45 m3 (see Table 6). The objective here is to harvest as much as possible and as soon as possible, but make sure it is merchantable.

Using the same column (medium) note that the site is producing a net mean annual increment of 3.4 m3/ha per year at age 60 (204/60) and that this barely increases to 3.41 m3/ha per year at age 70. Beyond this point while total production increases, the production per unit of time declines.

Table 13. Selecting the appropriate rotation for aspen

Total Age	Site Quality Class			
	Poor	Fair	Medium	Good
	(net yields m3/ha)			
40	8	37	81	112
50	63	97	144 2.9	**202** 4.0
60	105	148 2.5	**204** 3.4	**258** 4.3
70	135 1.9[a]	**181** 2.6	**239** 3.4	**298** 4.3
80	**159** 2.0	**205** 2.6	**261** 3.3	325 4.1
90	**177** 2.0	**225** 2.5	281	344
100	**190** 1.9	237	298	355
110	200	247	309	368
120	205	254	313	375

a. Mean annual increment: net volume divided by the age

From an investment point of view (unless other factors such as a premium price for larger stems/logs is available), the owner should proceed to harvest and establish a new stand.

Where a private investment has been made at a significant discount rate (say 6% real) shorter rotations usually provide a better financial return. In many cases the optimum financial rotation coincides with or comes shortly after the stand has been recognized as being merchantable. While hard and fast rules are not available to easily recognize when this occurs, a forestry check as to average stand diameter can usually denote when the stand is merchantable (i.e. average stand diameter has passed 12.5 cm dbh, or few stems are below 12.5 cm dbh and most are significantly larger).

For planning purposes Table 13 has been derived from Table 6 to denote target rotations that are estimated to be applicable to northeastern B.C. They consider merchantability for pulpwood, as well as obtaining as much production from the site as possible without significantly decreasing investment returns to private land forestry. The target area is shown in bold face type - the mid figure would be considered to be the safest if not the optimum choice.

Rotation for sawlogs cannot be well defined as stumpage prices and minimum log sizes/specifications have not as yet been identified. In general, 20 to 30 years past a pulpwood rotation may be necessary for sawlog production. If significantly higher prices are not expected for sawlogs versus pulpwood, harvesting for pulpwood usually provides a better financial return.

A further problem with growing aspen on long rotations for sawlogs is the apparent rapid decline in stand quality which is estimated to occur, depending on site, between 80 to 100 years. This phenomenon is not well documented but inventory data do indicate that aspen stands in age class 6 (101 to 120 years) have usually reached a point of deterioration such that merchantability may be questionable.

LAND-USE OPTIONS AFTER THE FIRST HARVEST OF ASPEN FROM A FARM WOODLOT

In the Peace River region there are three main choices of what to do with a woodlot after aspen has been harvested:

i) encourage a new aspen crop for long-term woodlot management;

ii) convert the site to forage production, not necessarily involving cultivation; and

iii) remove the stumps and prepare the site for cultivation.

Encourage a new aspen crop

The choice between agricultural use or forestry use following woodlot harvest will be influenced not only by the current economics of each option but also by the interests and attitudes of the landowner; these attitudes may be very much influenced by policies, incentives or disincentives of land management agencies.

In cases where encouragement of a new aspen crop is the chosen option there are several important considerations:

i) clearcutting is the most appropriate form of harvesting to encourage regeneration of aspen;

ii) there is considerable flexibility possible in the sizes and shapes of clearcuts to meet other land-use objectives; and

iii) long-term woodlot management may be well suited to periodic harvest removals over a long period instead of total liquidation all at once.

Clearcutting is the best silvicultural system to create conditions suitable for natural aspen regeneration. Clearcutting completely removes the stems and crowns, a necessary prerequisite that promotes root suckering and provides full sunlight for the optimum development and growth of the new stand (Davison et al. 1988). The number and vigor of young aspen decreases as the number of stems left standing after harvest increase. The size and shape of clearcuts can be adjusted to minimize visual impact or to meet goals other than timber production (e.g. wildlife habitat).

Farm woodlots can be considered as a bank account or cash reserve for emergencies. Periodic withdrawals can be made, for example, by harvesting 40 acres instead of all 160 acres in a woodlot. If several successive harvests are to be done on a woodlot, it is important to avoid or reduce repeated passage of heavy equipment over the same pieces of ground within the woodlot. Particularly on wet soils there may be reduced yields in the future if heavy equipment results in soil compaction or damage to aspen root systems. Roads and landings are often compacted to the point of being a deterrent to aspen re-establishment by suckering. Therefore, for regeneration of a new aspen crop, it is in the woodlot owners' best interests to limit the area devoted to landings and repeated passage of heavy equipment.

Encouragement of forage and use for grazing

For cattle to make full use of a recent aspen clearcut, hazards like logging slash and stumps need to be reduced. This can be accomplished in several ways. During logging, hydraulic shears ('snippers') or feller-bunchers can cut stumps flush with the ground, and the whole tree can be skidded to the landing for bucking and trimming. When the logging is finished, tops and debris can be piled on the landing and later burned. Alternatively, stumps can be sheared off or cut down with side cutters. All stumps and debris can then be windrowed for burning later, if needed. The goal is to have the surface free of hazards or obstacles for cattle, giving them access over the whole area.

Shearing and windrowing done in summer usually results in more mineral soil being exposed than in winter operations. This will increase the chances of good establishment of seeded forage. Shearing in winter may clear the surface of debris, but not provide a good seedbed for tame forages. Some landowners have used a seed drill to establish forage, rather than broadcasting seed.

Experience near Dawson Creek has revealed that broadcast seeding after winter logging has not provided good establishment of tame forage, probably because of a poor seedbed. In the second summer after logging, aspen regeneration has often been so dense that cattle will not go into it (C.Haddow 1990, pers. comm.)

Recent grazing trials near Grande Prairie showed that significant amounts of forage are available in aspen cutblocks that have been seeded with forages (Wheeler 1989). These trials also revealed that such areas can be grazed by livestock for several years without harming aspen regeneration.

In the Grande Prairie experiment, the area was logged in the spring of 1983 and seeded with tame forages that fall. Grazing began in 1984. Five years after logging, forage yields were equivalent to 1.1 acres per Animal Unit Month (AUM), and aspen regeneration was 47,000 stems/ha (19,000 stems/acre). A small exclosure had 70,000 stems/has of aspen (28,300 stems/acre) and yielded forage equivalent to 0.6 acres per AUM. Damage to aspen due to cattle grazing was not evaluated in detail. Scarring of young aspen may result in a high incidence of disease, reducing the value of the aspen at the next harvest.

The trial near Grande Prairie showed that at least five years of grazing may be obtained after aspen harvesting. As the aspen increases in height, and the tame forages decline in vigor, grazing potential gradually declines. Later, however, as the aspen stand develops and the number of trees decreases due to mortality, opportunities for cattle grazing will again increase, eventually reaching a level similar in quantity and quality to those of existing older stands.

The keys to combining cattle grazing with aspen regeneration are:

i) remove obstacles and hazards such as high stumps and slash;

ii) seed with tame forages to increase the quantity and quality of grazing (this requires good establishment of the tame forages); and

iii) fencing to keep cattle on the cutblock and using the forage that is available.

Conversion from forest land to agricultural land

After aspen harvest, stump removal is possible but more expensive than clearing and windrowing standing aspen to prepare land for breaking and cultivation. Equipment and techniques for clearing forest land are well known in the Peace River area.

ASPEN MANAGEMENT OPTIONS

When an aspen stand is clearcut, dense and vigorous regeneration of root suckers is almost assured. After harvest an aspen stand can be left alone until the next harvest with little, if any, management expenses. Therefore, a 'no management' option is a popular one. However, some woodlot owners, for their own reasons, may wish to take certain silvicultural steps to either increase wood production or to enhance the woodlot's value as wildlife habitat.

The 'no management' option

The literature dealing with pure aspen stands gives the impression that a 'hands-off' approach may be the most appropriate form of siviculture. For example, the Silvicultural Guide to the Aspen Working Group in Ontario sums up a commonly held viewpoint about stand tending in aspen:

> No cleaning, thinning or pruning of young aspen stands is recommended (Heeney et al. 1980)

This advise was modified slightly in the 1988 version of Ontario's silvicultural guide (Davison et al. 1988) with the words:

> Intensive practices, such as thinning, although not operationally practiced in Ontario, may be used in immature aspen stands to accelerate the diameter growth and thus improve sawlog and veneer production - when the markets and economics warrant it.

A similar viewpoint is evident in the United States aspen literature, as indicated by the advice of Perala (1972), cited below from DeByle (1976):

> Little care is needed once a fully stocked, rapidly growing, even-aged aspen stand has been established. If too dense, the stand will thin itself with little loss in growth due to competition.

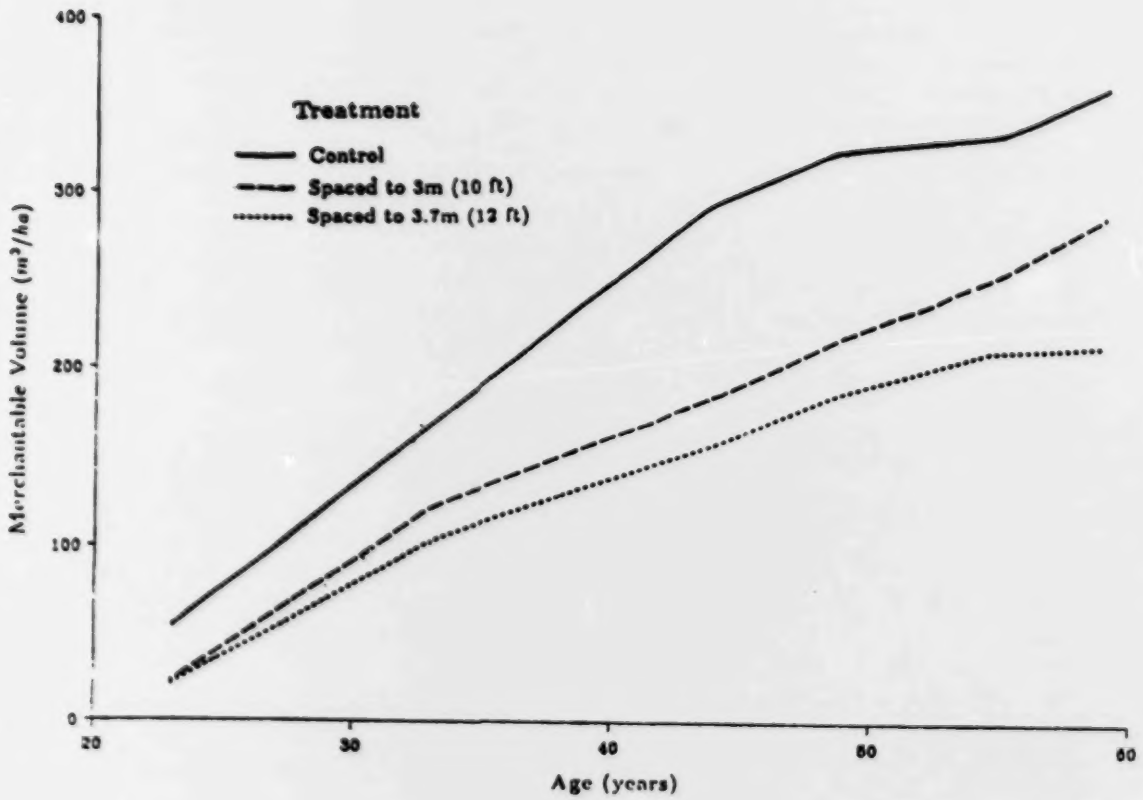
Should aspen be thinned or fertilized?

If the goal is to accelerate diameter growth to improve the value of aspen for sawlog and veneer production, then thinning should be considered; if the goal is to increase total biomass yield, then thinning is a questionable expenditure. Work by Steneker (1964, 1969, 1974) in the prairie provinces and by Zasada (1952) and Zehngraff (1949) in the Lake states gives ample evidence that thinning does stimulate the diameter increment of all tree sizes. However, Steneker (1976) recommended that thinning be considered, on good sites only, when the objective is to produce large trees for lumber or peeler logs in a short period of time. He felt that thinning would be unjustified if the anticipated end product from aspen or poplar were fibre or pulp. It is noteworthy that, with increased stem diameters not being critical for the desired product, the greatest basal area and greatest total volume occurred on unthinned control plots described by Steneker (1964).

Therefore, if an aspen manager's goal is to maximize total fibre yield, with no concern to produce large trees for a specific product that needs them, there is little reason to consider thinning in this species. The degree to which merchantable volume to close utilization standards is reduced as a result of thinning is shown in Figure 6, based on a recent review by Navratil et al. (1989). Figure 6 is based on volume data at age 59 for aspen thinned 36 years previously on relatively good growing sites in west-central Manitoba. The greatest volume occurs in unthinned stands, with the greatest decrease in production associated with the heaviest thinning.

There is also evidence that the incidence of Hypoxylon infection is greater in thinned than in unthinned stands, especially if thinning is done after trees are 10-15 m tall (Peterson et.al. 1989).

Figure 6 Merchantable volume of aspen in unthinned stands compared to two levels of thinning. These stands were on good sites in west-central Manitoba. Merchantable volume is defined by a stump height of 15 cm and top diameter, inside bark, of 8 cm (Source: Navratil et al. 1989)



Interprovincial forest fertilization trials described by Weetman et al. (1987) revealed that there were notable 5-year responses to fertilization in a 35-year-old aspen stand in Saskatchewan. The results can be summarized as follows:

Initial total volume in stand: 145 m3/ha

5-year increment:		% increase over control
in control area	33.5 m3/ha	--
N at 112 kg/ha	35.6 m3/ha	6.2
N at 224 kg/ha	49.6 m3/ha	48.0
N at 224 kg/ha and P at 112 kg/ha	50.1 m3/ha	49.6
N at 224 kg/ha and K at 112 kg/ha	59.4 m3/ha	77.3
N at 224 kg/ha and P and K at 112 kg/ha	70.8 m3/ha	111.3

These responses translate into increased yields ranging from an extra 6% of 5-year increment when N only was added at 112 kg/ha, to an extra 111% of 5-year increment when N at 224 kg/ha and P and K at 112 kg/ha were added.

Contrary to the results shown above, Steneker (1976) suggested that in boreal mixedwood stands, with a short growing season, fertilization would not greatly improve growth. Furthermore, because productive aspen sites are characterized by an abundant cover of understorey vegetation, the potential benefits of fertilization may be lost to uptake by ground vegetation. He suggested that control of understorey vegetation would be a greater stimulus to aspen growth than fertilization would be.

Slash management during and after woodlot harvesting

As indicated in an earlier section, if forage production and livestock grazing are planned after aspen is harvested then slash accumulation should be kept as low as possible. Slash can also have an influence on renewal of aspen stands. The additional shade created by slash can potentially lower soil surface temperature, which in turn can reduce sucker formation. Bella (1986) reported that following the harvest of aspen stands near Hudson Bay, Saskatchewan, sucker density was greatest where no slash cover occurred. Sucker density generally declined as the amount of slash increased from limbs only, to logs only, to limbs and logs. Average sucker density differed more, both relatively and absolutely, with slash condition after summer cutting than after winter cutting. Slash left by summer logging had the disadvantage of creating more shade than winter slash because of the foliage present. However, this effect appeared to be offset by the fact that summer logging disturbed the ground vegetation and humus more than did winter logging. As a result, areas logged in summer experienced warmer soil temperatures, which are known to promote root suckering.

Slash management guidelines developed by Steneker (1976) are considered to be relevant for northeastern British Columbia. In general, complete removal of the original stand, together with harvesting methods that knock

down much of the understorey vegetation, will ensure a fully stocked stand of suckers, provided the root system of the original aspen stand fully occupied the site. In overmature stands, which are likely to have heavy shrub vegetation, the preferred time for harvesting is during the frost-free dormant season to encourage the destruction of shrub vegetation. Most shrub vegetation will be destroyed or uprooted if complete trees are brought to a landing. However, the area may subsequently have to be treated with anchor chains or other equipment that will destroy residual shrubs (Steneker 1976).

If relatively fine slash can be spread so that it has better contact with the ground then decay is promoted. This helps retain nutrients on site and also reduces fire hazard.

Some examples of aspen woodlot management for wildlife habitat enhancement

If a landowner wishes to manage aspen for enhancement of wildlife habitat, the most important variable is the successional stage of the stand. Total animal biomass can be as much as eight times greater in a 10-year aspen stand than in a 40 year stand. The first 20 years of aspen stand development provide abundant natural browse needed to sustain a high biomass of deer, moose, beaver and snowshoe hare. As the aspen grows taller, populations of larger mammals decline, but the numbers and diversity of bird species increases (Gullion 1986).

Another variable that the woodlot owner can control is the size and shape of clearcuts. In the case of moose, clearcuts as large as 80 ha appear to be acceptable. In contrast, white-tailed deer prefer to remain within about 80 m of undisturbed cover, so aspen clearings of 25 ha or less are best for this species. Snowshoe hares show a preference for regeneration on very small clearcuts of 2 to 4 ha.

Work in Lake States aspen indicates that ruffed grouse are the most demanding in their requirements. They rely heavily upon the buds of male aspen for food. Numbers of grouse are usually greatest in situations where sufficient mature male aspen trees are within about 100 m of 10- to 25-year old aspen regeneration at densities of 5,000 to 19,000 stems per ha. This means that when individual cutting blocks exceed about 4 ha in size the benefits to grouse diminishes. Clearcut blocks 8 ha in area produce about 70% of the grouse achievable with 4 ha clearcuts (Gullion 1986).

Various harvesting alternatives for an aspen woodlot are shown in Figure 7 (reproduced from Figure 10 of Guillion, 1984), to demonstrate how effective grouse management might be achieved on a 16 ha (40 acre) woodlot. Variation A represents a commercial harvest. First, 4 ha would be clearcut from the southwest corner, followed by a second 4 ha cut in the southeast corner 10 years later; the northwest 4 ha would be the third cut, and the northeastern 4 ha becomes the final cut 30 year later. This schedule is used to assure that maximum sunlight reaches the ground in the last two cuts. By cutting the southern blocks first there will be some improvement in cover along the south edges of the two northern blocks long before they are cut.

Figure 7

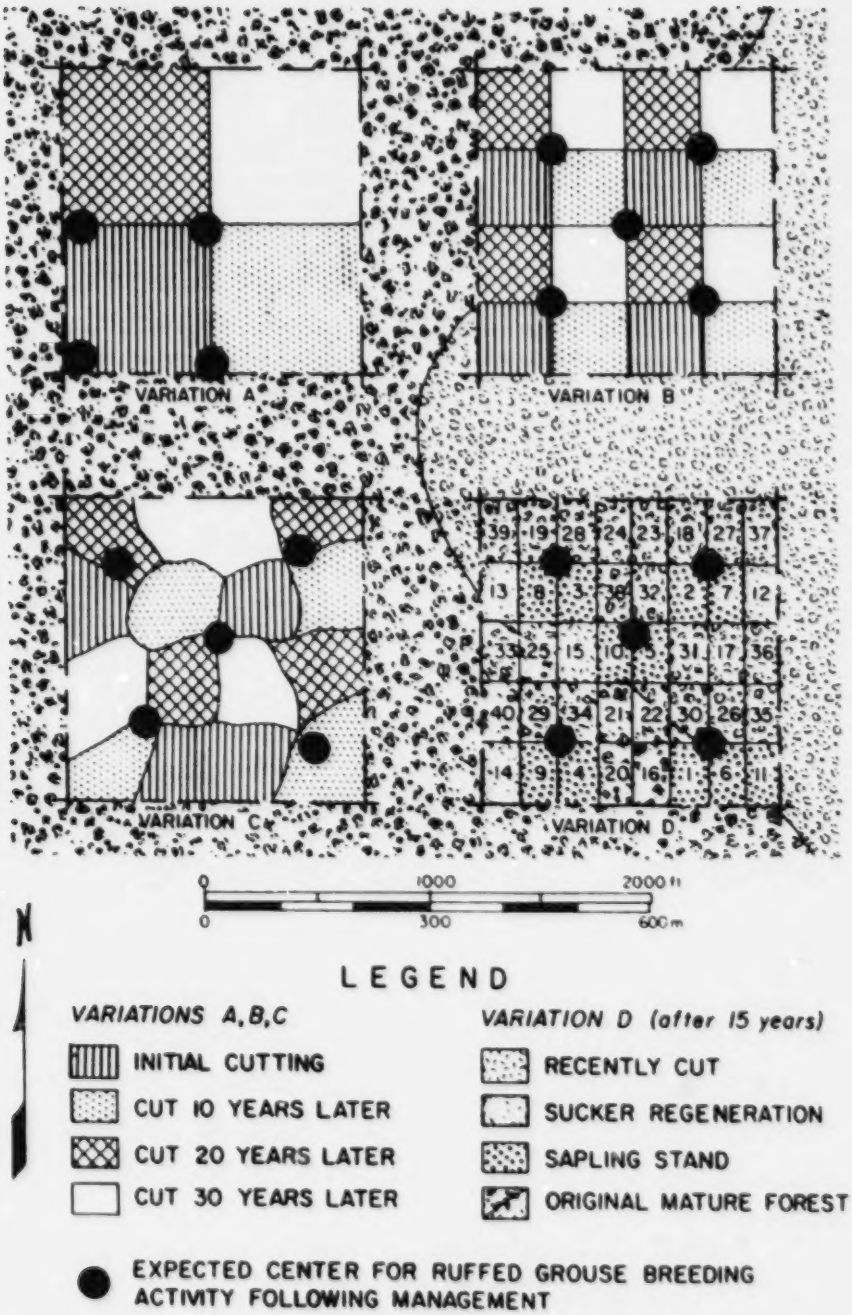

VARIATION A
VARIATION B
VARIATION C
VARIATION D
39 19 28 24 23 18 27 37
13 8 3 38 32 2 7 12
33 25 15 10 5 31 17 36
40 29 34 21 22 30 26 35
14 9 4 20 16 1 6 11
0 1000 2000 ft
0 300 600 m
N
LEGEND
VARIATIONS A, B, C
INITIAL CUTTING
CUT 10 YEARS LATER
CUT 20 YEARS LATER
CUT 30 YEARS LATER
VARIATION D (after 15 years)
RECENTLY CUT
SUCKER REGENERATION
SAPLING STAND
ORIGINAL MATURE FOREST
EXPECTED CENTER FOR RUFFED GROUSE BREEDING ACTIVITY FOLLOWING MANAGEMENT

FIGURE The Option I - a management prescription for a 40-acre tract, showing four alternatives for treating the same area. The blocks in Variation A are all 10 acres (4 ha) each; in Variation B, 2-1/2 acres (1 ha) in size; those in Variation C are about 2-1/2 acres (1 ha), except across the south side; Each block in Variation D is 1 acre (0.4 ha), with the numbers indicating the year that each block would be cut. Progress on Variation D is shown as it would appear 15 years after cutting began
(Source: Gullion 1984)

Variation B consists of a series of 1 ha clearcuts designed for the landowner desiring a maximum grouse population on the woodlot. The pattern of cutting would be the same as Variation A but in smaller parcels. Variation C is simply a more natural appearing variation of the basic pattern shown in Variation B, and is designed for the woodlot manager who objects to straight lines or square blocks in a forest setting. Variation D presents a cutting program for a landowner who would like to do some habitat management each year, on a few weekends, and is less concerned about cost and the marketing of timber products. It could be appropriate as a firewood cutting plan. In this variation a single 0.4 ha plot would be cut annually, in the sequence indicated by the plot numbers. These plots do not need to be square or rectangular. Gullion (1984) stressed that 0.4 ha (1 acre) of aspen regeneration, or even brush stems, seems to be the lower limit for the size of a patch acceptable to ruffed grouse as an activity centre.

WOODLOTS THAT CONTAIN ASPEN-CONIFER MIXEDWOODS

Some woodlots in the Dawson Creek - Fort St. John region contain mixedwood stands of aspen and white spruce or aspen and lodgepole pine. Typical yields for spruce and aspen on four site quality classes were listed in Tables 9 to 12. Comparable yield tables are not available for mixed stands of aspen and lodgepole pine.

For the present report, the emphasis is on one key aspect of mixedwood management, which is the preservation of understorey spruce when it is present on woodlots destined for aspen removal. Although regeneration of white spruce is considered to be difficult and expensive for small woodlot owners to undertake, if the landowner is fortunate enough to have mixewoods stands with understorey spruce special efforts to protect these seedlings or saplings are warranted.

Techniques developed by Froning (1980) to reduce damage to understorey white spruce by planned logging of aspen overstorey are consider to be applicable to northeastern British Columbia. In a experimental area near Hudson Bay, Saskatchewan, 56% of the spruce were damaged in the 60 ha area where the logging contractor was given no guidance on methods to reduce damage to spruce. In contrast, in a nearby 16 ha trial area, where logging was planned and the skidder operator was supervised, there was only 12% damage and 7% total destruction of the white spruce understorey after skidding. This degree of protection to the spruce was achieved in the following way. Surveys were conducted before logging to map the spruce understorey. Major skid trails were flagged, based on the stocking of white spruce, with sufficient flexibility to take advantage of gaps in the understorey. Bunching of aspen logs was done in the direction of skidding. Over 75% of the hardwoods were logged; those remaining were often in dense clumps of spruce which would not have been removed under normal conditions. Some other aspen trees were left standing to serve as "guard trees" for the deflection of skidded material around curves or turning points.

According to Froning (1980), vulnerability of spruce to windthrow is high when dense mixed stands are opened. Leaving some hardwoods reduces wind damage to critically exposed spruce trees, an important consideration in the development of silvicultural guidelines for spruce release from aspen (Johnson 1986). Froning (1980) also warned against logging hardwoods when temperatures are very low, as skidding whole trees under those conditions increases mortality and damage to understorey spruce.

Some woodlot owners in northeastern British Columbia may be interested in enhancing the value of their spruce component in mixedwood stands. There is now considerable experience with stand-tending methods to release spruce from aspen competition. This experience was recently reviewed by Johnson (1986). His guidelines can be summarized as follows:

- Present information suggests at least a 35% increase in merchantable white spruce volume following appropriate release from aspen overstorey.
- On a purely silvicultural basis, release of white spruce from aspen and shrubs is a viable forest management option.
- The greatest growth response for released white spruce appears to be in the 20- to 40-year old age class.
- White spruce over 75 years of age does not respond well to release from aspen overstorey.
- Gross total yields of well-stocked mixedwood stands are not changed significantly by release treatments. However, growth is concentrated on the conifers, usually the preferred species.
- Rotation age of spruce in pure stands is 30-40 years less than in mixedwood stands, due to aspen competition in the latter.
- White spruce understoreys must be at least 2.5 m tall to stay ahead of new aspen sucker growth and shrub competition subsequent to a single manual release treatment.
- If white spruce seedlings are less than 2.5 m tall at the time of release they will likely require at least one additional release treatment (Johnson 1986).

Based on Johnson's recommendations and the spruce/aspen yields shown in Tables 9 to 12 a first harvest of aspen can be followed at a later date by a more valuable spruce harvest. In converting to spruce, timing is very important. A forestry check of the woodlot should be made to see that:

(a) the aspen is merchantible and has produced as much volume as possible;

(b) there is sufficient spruce (number of stems to fully occupy the site) and that they are tall enough to stay ahead of the new aspen sucker growth which will occur; and

(c) that the spruce are vigorous and not excessively old such that they will not respond to release.

For poor and fair sites spruce will be approaching the maximum age for release at the time the aspen is just becoming merchantable. The time window with this situation is very narrow but should be best at about 70 to 80 years. A forestry check should be made at about 60 years to estimate if appropriate conditions are developing. On medium and good sites the aspen should be merchatable at 60 to 70 years and the spruce ideally suited to release. Again, a check should be made a few years earlier to see if appropriate conditions are materializing and an estimate of the harvest/conversion made for planning purposes.

Where the aspen in an aspen-spruce stand is not intended to be grown to a merchantable rotation (i.e. poor quality and/or low volume, or other ownership objectives), spruce may be released at an earlier age if desired. As noted in Johnson's recommendations the best timing for growth response would be when the spruce is 20 to 40 years of age.

Once the aspen has been harvested and the spruce stand established, the spruce should be allowed to grow until the stand is merchantable. On poor and fair site this will likely be to an age of 120 years or longer. On medium and good sites, depending on the price of spruce pulpwood versus sawlogs, 110 years to 120 years should suffice. As stands on these sites reach their maximum production at about 100 to 110 years harvest should be contemplated at this time, or slightly earlier if the stand is merchatable for pulpwood and the price for pulpwood is relatively high. If the price for pulpwood is relatively low compared to sawlogs the rotation can then be increased. From an investment point of view extending a rotation 20 to 30 years means sawlogs should be worth some four times the price of pulpwood on a per m3 basis.

4. COSTS OF HARVESTING, TRANSPORT AND MANAGEMENT

HARVESTING

Harvesting or logging costs are shown in Table 14. They were compiled on the basis of interviews in the Dawson Creek area of B.C. in September 1989. Some 17 loggers, or landowners that logged or contracted logging, provided data. The sample included loggers of all sizes (production) but six were considered large in size.

The estimates shown in the table are averages where possible, but a range is given when it was clear that cost varied within a firm (i.e. degree of difficulty). The reader should note that aspen logging differs somewhat from conifer logging in that felling is frequently done by machine, skidding is usually tree length and that bucking (100" bolts) is usually done at the landing. Bucking can be done manually or by machine. If a machine is used (cutting/grapple head) the bolts are piled carefully to increase loading efficiency.

The four logging components (felling, skidding, bucking and loading) are frequently related to a system that was used by the logger depending on the experience and the size of the firm. These combinations are shown at the bottom of Table 14, with the average total logging cost of the four components.

TRANSPORTATION

Hauling costs for aspen are shown in Table 15. Some 12 firms reported costs, usually more than one based on kilometers hauled. The data were fairly consistent and more than one firm reported the same rate for the same distance. No attempt was made to calculate an average haul distance or cost, but hauls of less than 50 km were most common for private wood. Wood from Crown land usually came from farther away than farm wood. The most common truck used carried 25 tonnes but some smaller "farm" trucks were also used. Large firms frequently used "B" trains which carried 33 tonnes.

Table 14. Aspen Logging Cost Components Dawson Creek Area of B.C.

Component	Cost ($/m3)	Comments
Felling	1.50 - 2.00	. hand felling depending on experience and hourly rate
	2.00 - 2.25	. cat or tractor with hydraulic shears ("snipper cat")
	3.00	. feller-buncher
Skidding	3.00	. grapple skidder
	4.00 - 4.50	. line skidder
	5.00	. old line skidder; misc. tractors
Bucking	2.00 - 2.50	. by hand, cost varies by terrain, size and quality of landing space and size of timber
	3.00 - 3.50	. wood processor; cost varies by type of skidding and degree of piling for ease of loading
Loading	2.00	. after wood processor bucking and careful attention to piling for loading
	3.00	. general cost; best hand bucking situations, more difficult wood processor situations
	3.50	. general cost after hand bucking

Most frequent combinations:	Total Cost ($/m3)
A. Firm or Farm with limited experience and equipment	$ 13.00
B. Small logger, "Snipper" cat and Line Skidder	$ 12.00
C. Large logger, "Snipper" cat, Grapple Skidder, Processor	$ 11.00
D. Large logger/Contractor, Feller-buncher, Grapple Skidder and Processor	$ 11.75

Note: Type D were all low margin large volume processors

SOURCE: Compiled on the basis of personal interviews with firms in the Dawson Creek area.

Table 15. Aspen Hauling Costs, Dawson Creek Area of B.C.[1]

Haul Distance (km)	Cost Per m3
1 - 20	4.00
21 - 30	5.00
31 - 40	6.00
41 - 50	6.50
51 - 60	7.00
61 - 70	7.50
71 - 80	8.00
81 - 90	8.50
91 - 110	9.00

1. For hauling 100" aspen sticks using 25 tonne 5 axle trucks or 33 tonne "B" trains. The former were more prevalent than the latter, but larger firms favoured the "B" train. Some data were available to indicate "B" trains were about 10-15% more efficient on a cost per m3 basis. Does not include loading.

SOURCE: Compiled on the basis of personal interviews with firms in the Dawson Creek area.

MANAGEMENT COSTS AND PRICES

Other costs and prices pertinent to aspen management and production in the Dawson Creek area are shown in Table 16. Stumpage ranged from $0.50 per m3 to about $3.00 per m3, depending on the type of sale. Not including bonus bids, the price for Crown timber (hardwoods) is $0.50 per m3. Small Business Enterprise Program sales, in addition to the $0.50 per m3, usually included a bonus bid of $1.25 to $1.50 per m3. Private landowners who had sold stumpage and logging firms purchasing stumpage reported a range of about $1.00 to $3.00 per m3.

In general, stumpage close to Dawson Creek (less than 25 km) sold at the high end of the range and stumpage farther out sold at the low end of the range. The average reported was $2.25 per m3 for private sales less than 40 km but more than 10 km from Dawson Creek.

Expenditures for roads or landings on private land were the exception rather than the rule. Most harvesting on private land that was observed in the area had road access and suitable spots for landings. A very common occurrence was skidding to adjacent fields or pasture land accessed by a farm road for bucking and loading. The $0.75 per m3 reported was for larger woodlots (both Crown and private) having both spruce and aspen that required access off a secondary road and a small amount of landing preparation.

Table 16. Other Costs and Prices Pertinent to Aspen Management and Production in the Dawson Creek Area

Type of Cost Or Price	Price or Cost & Unit of Measure	Comments
Stumpage	50 ¢ /m3	. Crown stumpage charge for for hardwood timber in pulpwood agreements or other cutting rights not including bonus bids
	1.75 - 2.00/m3	. average recent bonus bids plus the above charge in SBEP sales
	1.00 - 3.00/m3	. recent stumpage prices offered private land owners; average $2.25/m3
Roads & Landings	0 - 75¢ /m3	. largely applicable to larger woodlots with conifer; or aspen logging on Crown lands; minimal on private farm related land
Land Taxes (annual)	69¢ to 77¢ /ha	. reported taxes on undeveloped treed farm related land
Delivered Mill Price*	18.50 to 22.50 per tonne	. prices paid to contractors including Crown stumpage. Variation relates to haul distances
	20.50 per tonne	. price paid under open gate policy for "local" wood

* Delivered wood subject to "Log Quality Specifications" as published by the mill. Mill conversion factor for weight scaling 977 kg = 1 m3

Taxes for undeveloped forested land were about $0.70 to $0.75 per hectare. As assessments were consistent within municipalities the variation is related to minor discrepancies in exact parcel size and the accuracy with which acres were converted to hectares.

Prices for aspen timber in the area currently relate to one forest products facility - namely, the oriented strandboard mill of Louisiana-Pacific Panel Products Ltd. located at Dawson Creek. The mill basically procures wood in two ways. One is through contractors and the other is through purchasing at the mill. In the first instance the delivered price paid to the contractors is $18.50 to $22.50 per tonne depending on the haul distance. In general, this relates to a median price of $20.50 with short haul wood priced at $18.50 and long distance wood at $22.50 per tonne.

The price includes Crown stumpage charges. If the wood originates from the Company's Pulpwood Agreement Area (No. 10) the implied price to the contractors would be approximately $18.00 to $22.00 per tonne with the Company paying the $0.50 per m3 Crown stumpage charges.

The second means of procuring wood is by direct purchasing at the mill. This is generally referred to as an "open gate" policy for local wood. The delivered price paid under this policy is $20.50 per tonne. Delivered wood is subject to "Log Quality Specifications" as published by the Company. As the wood is weight scaled, a conversion factor is necessary to considered prices on a per m3 basis. The reported mill conversion factor was 977 kg = 1 m3 of sound solid wood not including bark. Locally, one tonne of aspen bolts (sticks approximately 100 inches long) is equated to one cubic metre.

The cost of forest management for private aspen land was estimated by the consultants for various sizes of ownerships. These are shown in Table 17. They are based on competitive rates for a professional forester and specialized technical assistant to provide basic forest management for aspen woodlots of the size noted. They include a basic management plan for the woodlot including sufficient field work to denote age classes or subcompartments within the woodlot and the expected yield and timing of harvest for each, plus management recommendations. They also include on-site planning, monitoring and recommendations for harvesting and regeneration. Owner management (overhead) or labour costs were not included.

In general, managing an aspen woodlot should cost about $1.00 to $3.00 per hectare per year depending on the degree of management and the size of the woodlot. On a sustained yield basis, depending on site quality as well as degree of management and the size of the woodlot, management costs would range from $0.25 per m3 of harvest to $1.60 per m3 of harvest. Estimates for two degrees of management, four woodlot sizes, and four site qualities are specified in Table 17.

Table 17. Estimated Forest Management Costs, Private Land Aspen, Northeast British Columbia, 1989

Level of Management[1] and Unit of Measure	Size of Area Managed			
	1/4 Section (65 ha)	1/2 Section (130 ha)	1 Section (260 ha)	1-1/2 Sections (390 ha)
Management Provided by Professional				
- Per Hectare Per Year	$3.45	$2.85	$2.30	$2.10
- Per m3 of Harvest[2]				
Good Site	0.85	0.65	0.50	0.45
Medium Site	0.95	0.85	0.65	0.60
Fair Site	1.40	1.15	0.90	0.85
Poor Site	1.60	1.50	1.20	1.05
Owner with Assistance by Professional				
- Per Hectare Per Year	2.30	1.70	1.30	1.15
- Per m3 of Harvest[2]				
Good Site	0.60	0.40	0.30	0.25
Medium Site	0.65	0.50	0.35	0.30
Fair Site	0.90	0.70	0.50	0.45
Poor Site	1.05	0.90	0.70	0.60

1. Professional Management - Forester (RPF) provides a 5 year management plan and oversees implementation (i.e. harvesting and regeneration).

   Landowner with Assistance - Forester (RPF) assists owner with a management plan and advises on harvesting and regeneration.

2. Per m3 of harvest based on target yields shown in Table 6. Harvest every five years. Assumes sufficient mature timber such that 5-years of mean annual increment can be harvested on an area control basis within five years.

5. COMPARISONS BETWEEN AGRICULTURE AND WOODLOT CROPS

In order to compare the production of agricultural crops and the management of a similar sized area for aspen, simple production models were formulated using as a basis models developed for use in the Peace River area.

The aspen production model, while following the same format as the agriculture models, varied in operational procedures to the extent that a harvest was made every five years rather than annually. The farm size considered was 400 ha, which would be mainly class 4 but could include class 5 agriculture land. This was equated to medium site for forestry yield purposes. For grain farming the land was assumed to be cleared and in a more or less contiguous block.

Aspen, hay or pasture were considered on the basis of one or more parcels, if not contiguous, in fairly close proximity. The hay or pasture land was considered on a cleared basis and the aspen land on a sufficiently stocked basis that a cut could be made on a 28.6 ha component every 5 years (continuous production based on a 70 year rotation).

No attempt was made to analyze the much more complex situations of converting agricultural land to aspen forest or the reverse. Similarly, simple assumptions were used that appeared to be the norm in the area that eliminated the testing of an excessive number of combinations. The landowners residence was not considered. For grain farming an average quantity of farm machinery and service buildings were included as well as the land. For aspen and hay only the land was included as any machine use was purchased. For pasture the land was considered as well as the investment in fencing and water dugouts. In all cases the land was assumed to be already owned and had a value of $100 per acre or $247 per ha.

The objective of the comparisons was to ascertain annual gross income, annual owner costs not including capital servicing, and hence an annual pre-capital farm net. A cash flow analysis was then run to determine if the capital could be serviced and if the investment would return 6% real.

The intent of the analysis is to obtain a general idea of farming versus aspen woodlot management as a viable enterprise.

The intention is not to point out so to speak "profitable" situations or rank opportunities as specifics or unique situations depending on landowner objectives were known to vary considerably. Note, for instance, that off farm income is normal in the Dawson Creek area. Thus, "making a living" at farming or from growing aspen may or may not be the appropriate issue to address. However, an adequate return to investment is a vital issue to all business endeavors.

The models and cash flow analyses are shown in Appendix 2 along with comments concerning the Dawson Creek situation and the assumptions used. Pertinent sources of information specific to the agriculture situation are also listed in Appendix 2.

GRAIN PRODUCTION

Grain farming showed wide variation in viability of the farming enterprise as can be seen in Table 18. The five cases studied showed situations that varied from a significant loss on the investment to one where the enterprise could be valued at over one million dollars.

This variation, other factors being held constant, was attributed to grain prices, variation in inputs and management and variation in yields. The Grain 2 scenario[1] which was intended to mirror the more or less average situation indicates the "average" enterprise to be uneconomic. The annual pre-capital net is only about $14,000 although owner labour can capture about a further $15,000 annually. This amount of cash flow cannot cover the necessary farm equipment needed ($148,000 depreciated over 8 years) and return anything to the land investment. On the other hand using higher inputs, and assuming high yields are attained, can turn the enterprise into a very attractive operation even at the lower 1989 crop prices (Grain 3 and 3a). Alternatively, lowering inputs but attaining average yields can be attractive if relatively high prices are attained (Grain 4a), or unattractive if prices are lower (Grain 4).

Grain farming in the Dawson Creek area of B.C. appears to vary widely as to the viability of the enterprise. Where the situation appears to be one of average or low prices and average or low yields a reasonable return to the investment appears to be suspect. The aspen scenarios which follow do not provide the scale of return that grain farming does. However, where circumstances clearly indicate grain farming is likely to be marginal an aspen woodlot could prove to be the better investment.

ASPEN PRODUCTION

Aspen production is shown in Table 18 based on medium site and current average costs and prices (Aspen 1). This scenario provides an annual pre-capital farm net of $3,900 and indicates a further $9,500 can be captured annually by owner labour. As the aspen scenarios did not include owning any machine capital, the land involved is the only capital to be serviced. The positive cash flow was adequate to do this and the return to the enterprise yielded more than 6% real.

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1. Grain 1 was deleted as it was the same as Grain 2 except for having 1989 prices which were lower than the long term prices used.

Table 18. Selected Comparisons between Agriculture and Aspen Management in the Dawson Creek Area of B.C. 1989

	Annual Gross Farm Income	Annual Total Owner Costs	Annual Pre-Capital Farm Net	Total 25-year Cash Flow	Enterprise NPV for 25-year @ 6% Real	Imputed Annual Owner Labour
Grain 2	111,616	97,220	14,396	-71,265	-194,935	14,828
Grain 3	209,369	100,061	109,308	2,301,560	1,018,372	14,828
Grain 3a	151,866	100,061	51,804	836,960	283,278	14,828
Grain 4	80,041	79,198	843	-410,090	-368,187	14,828
Grain 4a	111,616	79,198	32,418	379,285	35,447	14,828
Aspen 1	27,997	24,054	3,943	166,425	6,738	9,570
Aspen 2	27,587	24,054	3,533	154,132	158	9,570
Aspen 2a	27,587(38,240)	24,054	3,533(14,186)	367,183	81,142	9,570
Aspen 3	21,012	18,338	2,674	128,385	-13,621	7,175
Aspen 4	21,884	18,338	3,546	154,519	366	7,175
Hay 1	51,200	35,660	15,540	383,580	96,730	none
Pasture 1	14,820	11,295	3,525	114,445	-60,681	none

Notes to Table 18:

Grain 2 - Average farm costs but high wheat and barley prices (20 year average; 1989 prices lower)
Grain 3 - Average farm costs, high wheat and barley prices, higher inputs fertilizer, higher yields, no crop insurance.
Grain 3a - Same as 3 but 1989 crop prices
Grain 4 - Average farm costs, 1989 crop prices, low inputs of fertilizer and herbicides, average yields and low crop insurance
Grain 4a - Same as 4 but high crop prices

Aspen 1 - Average 1989 costs and prices
Aspen 2 - Average 1989 costs and assumed price of $20.20 per tonne (the price at which the enterprise returns 6% real as an investment).
Aspen 2a - Average 1989 costs and an assumed price of $20.20 per tonne increasing to $28.00 per tonne in 10 years (reflects developing pulpwood scarcity and the opportunity cost of alternative sources of pulpchips).
Aspen 3 - Same as Aspen 1 but Fair site
Aspen 4 - Same as Aspen 2 but Fair site and a price of $21.35 per tonne to yield a 6% real return.

Hay 1 - Average 1989 costs, average yields and 1989 prices.

Pasture 1 - Average 1989 costs, average yields and 1989 rental rates.

In a second scenario (Aspen 2) a lower price for aspen was assumed such that 6% real would be the return to the enterprise. This price was found to be $20.20 per tonne or a decrease of $0.30 per tonne over the 1989 price. At this price the annual pre-capital farm net would fall slightly to $3,500 annually.

Aspen 2a speculates that a further price increase in aspen could occur in the next 10 years (Massie et al. 1990) because of relative pulpchip scarcity. In this scenario a price of $28.00 per tonne was injected into the 25 year cash flow analysis at year 10 on the basis of an expected price of delivered coniferous pulpwood of $30 to $32 per m3 in the Prince George Region by the late 1990's. Hardwood pulpwood prices would likely be somewhat less than those forecast for coniferous pulpwood. Scenario 2a then indicates a pre-capital farm net of about $3,500 annually rising to about $14,200 annually should the price increase occur. This provides a large positive cash flow and a return to the enterprise of substantially more than 6% real.

Aspen 3 and 4 are repeats of the same situations as Aspen 1 and 2, but the assumed site quality is now fair instead of medium. In this situation lower yields from decreased site quality cause the farm net to decline about $860 to $2,674 annually. As the NPV is negative, the yield is less than 6%. Aspen 4 indicates the price necessary to yield 6% real ($21.35) for this fair site.

HAY PRODUCTION OR PASTURE

The production of hay in the Dawson Creek area of B.C. based on average 1989 costs and prices appears to be a worthwhile enterprise. Pre-capital farm net was estimated at about $15,500 annually and as custom rates (no machine capital owned) were used, the return to owning the land and managing for hay yielded in excess of 6% real. Data were not available to test the option of owned machinery and the use of owner labour.

The rental of pasture at 1989 costs and prices was estimated to be less worthwhile. The annual pre-capital farm net indicated was only about $3,500 and this was not sufficient to justify the investment in land and fencing. The return to the enterprise was substantially less than 6% real.

PRODUCTION COMPARISONS

Based on a scale of about 400 ha some general comparisons can be made with respect to managing aspen versus three types of agriculture. Grain farming, depending on circumstances, can be a very worthwhile enterprise or a very marginal enterprise. Where conditions are favourable, returns to investment appear to be well in excess of 6% real and sufficient farm income is generated to support the farm family. Where conditions are not favourable, the investment may generate little if any return and farm income will likely be insufficient to support a farm family.

In comparison, aspen production will not generate sufficient income to support a farm family, but can still be a sound investment and return significant net income. The production of hay appears to be a somewhat better option under current conditions and the investment yield is well above 6%. If some labour could be captured, income might be sufficient to support a farm family. Using the land for pasture under current conditions appears to be less attractive than either aspen management or hay production and the investment yield is less than 6%.

In summary, successful grain farming has an investment potential well above the other land use options. Marginal grain farming, hay production, aspen management and pasture rental have a much lower investment potential. This last group of options, however, can still provide sound investments in specific circumstances. The analysis presented here is insufficient to identify the exact conditions where one might be favoured over the other.

For anyone considering the aspen option, three points should be included in their evaluation. First, ownership of aspen stocked land would be an advantage as clearing the land for farming would incur additional land costs. Second, aspen management would not be at risk from annual weather patterns to the same degree as farming, and third, prices for timber are rising and forecast to rise, while the price outlook for grains and hay are uncertain at best.

6. CONDITIONS NECESSARY FOR ASPEN MANAGEMENT ON PRIVATE LAND

WOODLOT LOCATION AND SIZE

The viability of a commercial aspen woodlot is highly dependent on location as trucking is a significant cost component and the wood is usually priced on a mill delivered basis. The value of standing timber (stumpage) usually reflects a net down procedure such as:

Example A		Example B	
Delivered price	$20.50 per unit	Delivered price	$20.50 per unit
Less Hauling Cost	5.00	Less Hauling Cost	6.50
Less Logging Cost	12.00	Less Logging Cost	12.00
Approx. Stumpage	$ 3.50	Approx. Stumpage	$ 2.00

The difference in stumpage of $1.50 relates to a location that is farther from the mill, and could be described as the transportation cost for hauling an extra 20 km. In this example, for instance, Woodlot A was located 25 km from the mill and Woodlot B was located 45 km from the mill.

In actual practice the simple example above is complicated by other factors such as a margin for profit and risk for trucking firms and loggers, as well as the factors which establish the mill delivered price.

The main point being considered here is that the closer the woodlot is to a mill or purchasing point, the higher the value of stumpage or standing timber.

In addition to the above, any characteristics of the location that reduces hauling or logging costs, increases the potential for stumpage. Thus, slightly higher stumpage might be the case for woodlots adjacent to good roads, those that are easily accessible, those that have level, well drained ground, those that have dry flat areas for bucking and loading, etc.

The area managed for aspen production can vary significantly in size. In general, larger woodlots have some advantages. First, there is more flexibility in managing and harvesting. For example, continuous periodic harvests can be planned and also adjusted if prices change or if revenue is needed at a particular time. In general, the larger the woodlot, assuming an area to harvest that is adequate in size to justify setting up logging and hauling systems and provide sufficient wood

volume to satisfy a market purchase, the shorter the time span between harvests. Income every year or every two to five years can be more desirable than, say, income every 8 to 10 years.

Based on land use patterns in the Dawson Creek area of B.C., estimates of aspen growth and yield, and estimates concerning expected forest products manufacture, woodlots from 160 acres to 1,280 acres (65 to 518 hectares) appear to be the most practical. Smaller woodlots are still feasible, but would be slightly more difficult to manage and would return less revenue at less frequent if not irregular time periods.

Woodlots or forests greater than 1,280 acres or two sections are also feasible, but tend to assume management characteristics of a forest rather than a woodlot. They may not necessarily relate to farms, tend to be independent enterprises rather than farm related, require more complex management strategies, may relate to different management or land use objectives, and have a potential for different tax and investment implications.

STAND CONDITIONS FOR HARVEST

Several factors need to be considered in contemplating an aspen harvest. Where the stand is fully mature or overmature, harvesting may be necessary to establish a new stand. If a market is not available because of low volumes or poor quality the use of the timber for firewood might be considered. Delaying harvest can jeopardize good regeneration as sufficient root systems for suckering are needed to establish a well stocked new stand. Suckering is promoted by light and heat, hence the stand should be clear cut. The time of year for harvest appears to make little difference in promoting regeneration.

Overmature stands have relatively large diameter stems and relatively few small stems. In addition, broken stems and dead or broken tops are frequently evident. Mature stands, depending on site, are more difficult to define. In general, the average stem size of the stand is near 20 cm (8 inches) for all stems greater than 2.5 cm (one inch) at breast height. Total stems per hectare should be about 1075 to 1150 (for fair to medium site).

Depending on available markets, stands can be harvested as they approach maturity. This is particularly true if the market is for bolts for chipping or for pulpwood. Also, an early harvest usually increases the return on investment. Stands applicable to this situation should have an average diameter of 15 cm (6 inches) for all stems 2.5 cm or greater at breast height and the number of stems per hectare should be about 1700 to 1950 (for fair to medium site). In the early mature situation, the better the site, the greater the number of stems.

Harvesting should also take into consideration the objectives of the owner, the management plan (e.g. periodic sustained yield) and be of sufficient size (e.g. area and/or volume) to be economic. In addition, stand characteristics as previously described should be estimated against current market specifications to make sure the harvest is

merchantable. In all cases, the market must be purchasing and the price being paid must be adequate to provide a reasonable return.

RETURNS TO INDUCE MANAGEMENT

In order to induce aspen management on private forest land, the return on the investment should meet or exceed the landowner's next best alternative. Some of these alternatives with respect to agriculture were discussed previously and it appears that land stocked with aspen, considering land clearing costs, can provide a return comparable to or better than marginal agriculture situations.

The following situations are discussed in order to provide examples where conditions for aspen management would be favourable.

The locations considered pre-suppose a central manufacturing location such as discussed in the Inventory Section and relate to private land distances from the manufacturing centre (transportation costs) as well as a low, medium, and high logging cost. They include forest management costs, land taxes and a target rate of return of 6% real on the investment based on the return to selling stumpage. The base cases (medium site, 70 year rotation; and fair site, 80 year rotation) both consider large woodlots of 260 hectares to 518 hectares (or one to two sections) and an even flow periodic harvest every 5 years.

Medium site yielded a $3.20 per m3 break-even stumpage price at a 6% real rate of return. Fair site yielded a $4.35 per m3 break-even stumpage price at a 6% real rate of return. As smaller woodlots are slightly more expensive to manage, slightly higher stumpage rates are applicable. These can be approximated by adding 30 cents per m3 for medium site and 50 cents per m3 for fair site, and would be for woodlots of less than one section (259 ha) in size.

Table 19 has been formulated to show the delivered wood price necessary to return the break-even stumpage prices given the woodlot distance from the manufacturing or purchasing centre as well as three levels of logging cost to reflect modest variation in logging conditions and operator efficiency. The table can be used to quickly approximate the delivered price per m3 necessary to manage an aspen woodlot. Caution is urged in the use of the table as it is based on 1989 costs and prices and assumes average but reasonably efficient hauling and logging costs.

If the stumpage rate required to induce management is the figure of interest rather than the delivered price, it can be derived from the table by subtracting the logging cost and hauling cost expected for the situation from the market price shown in the table. For instance, a farm woodlot of some 80 ha located 45 km from a delivery point is considered to be medium site and expected to incur average logging costs. The estimated delivered price needed from the table would be $22.00 per m3, and the stumpage rate would be $3.50 per m3 ($22.00 minus (12.00 + 6.50)).

Table 19. The Market Price Required to Yield Six Percent Real for Managing Aspen Woodlots[1]

When Haul Distance and Cost (km)	($/m3)	Market Price Needed ($/m3 delivered) When Logging Cost ($/m3) Low $11.00	Medium $12.00	High $13.00
MEDIUM SITE (Woodlots Over One Section or 260 ha in Size)				
1 - 20	4.00	$ 18.20	$ 19.20	$ 20.20
21 - 30	5.00	19.20	20.20	21.20
31 - 40	6.00	20.20	21.20	22.20
41 - 50	6.50	20.70	21.70	22.70
51 - 60	7.00	21.20	22.20	23.20
61 - 70	7.50	21.70	22.70	23.70
71 - 80	8.00	22.20	23.20	24.20
81 - 90	8.50	22.70	23.70	24.70
91 +	9.00	23.20	24.20	25.20
MEDIUM SITE (Woodlots Under One Section or 260 ha in Size)				
1 - 20	4.00	18.50	19.50	20.50
21 - 30	5.00	19.50	20.50	21.50
31 - 40	6.00	20.50	21.50	22.50
41 - 50	6.50	21.00	22.00	23.00
51 - 60	7.00	21.50	22.50	23.50
61 - 70	7.50	22.00	23.00	24.00
71 - 80	8.00	22.50	23.50	24.50
81 - 90	8.50	23.00	24.00	25.00
91 +	9.00	23.50	24.50	25.50
FAIR SITE (Woodlots Over One Section or 260 ha in Size)				
1 - 20	4.00	19.35	20.35	21.35
21 - 30	5.00	20.35	21.35	22.35
31 - 40	6.00	21.35	22.35	23.35
41 - 50	6.50	21.85	22.85	23.85
51 - 60	7.00	22.35	23.35	24.35
61 - 70	7.50	22.85	23.85	24.85
71 - 80	8.00	23.35	24.35	25.35
81 - 90	8.50	23.85	24.85	25.85
91 +	9.00	24.35	25.35	26.35

When Haul Distance and Cost (km)	($/m3)	Market Price Needed ($/m3 delivered) When Logging Cost ($/m3) Low $11.00	Medium $12.00	High $13.00
FAIR SITE (Woodlots Under One Section or 260 ha in Size)				
1 - 20	4.00	19.85	20.85	21.85
21 - 30	5.00	20.85	21.85	22.85
31 - 40	6.00	21.85	22.85	23.85
41 - 50	6.50	22.35	23.35	24.35
51 - 60	7.00	22.85	23.85	24.85
61 - 70	7.50	23.35	24.35	25.35
71 - 80	8.00	23.85	24.85	25.85
81 - 90	8.50	24.35	25.35	26.35
91 +	9.00	24.85	25.85	26.85

1. Estimates derived by cash flow analyses using costs, prices, yields, and management strategies discussed in the report.

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REFERENCES

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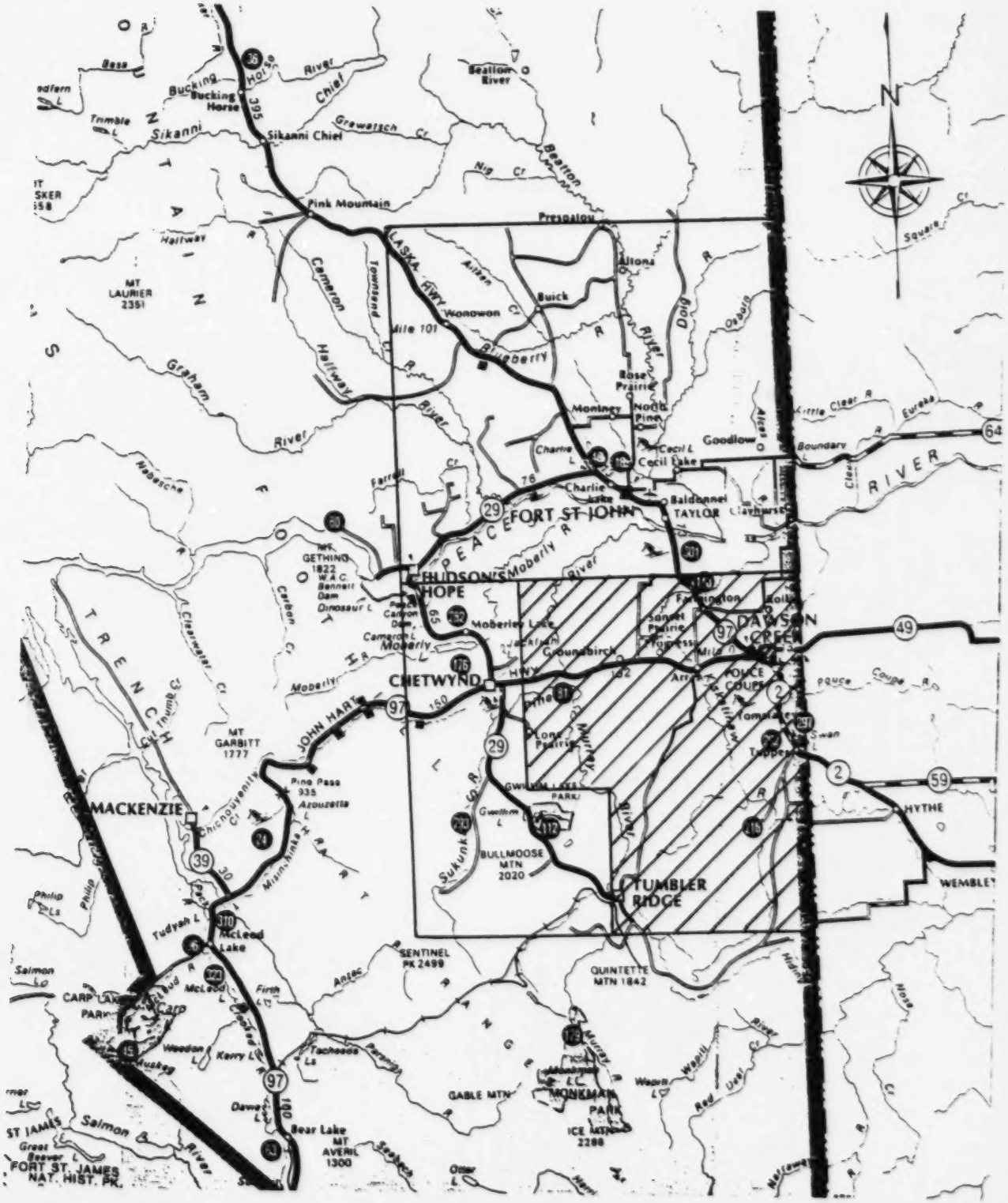
APPENDICES

APPENDIX 1

Area of New Inventory and Old Inventory Used in the Study



Dawson Creek Area of B.C., New (1988) Inventory Statistics
Compared to Previous (1970) Statistics for Forest Land
Having a Significant Aspen Component[1]

Ownership	Hectares		Aspen Only		Other Species Component		Total All Species	
Crown Managed Lands	1970	1988	1970	1988	1970	1988	1970	1988
Immature	80,091	137,105	2,541	5,150	867	2,639	3,408	7,789
Mature	164,441	130,889	16,072	11,400	16,962	15,864	33,034	27,264
Total	244,532	267,994	28,613	16,550	17,829	18,503	36,442	35,053
Private Lands	1970	1988	1970	1988	1970	1988	1970	1988
Immature	37,554	54,445	1,825	2,804	238	756	2,063	3,560
Mature	47,500	27,781	6,246	3,868	2,653	1,494	8,899	5,362
Total	85,054	82,226	8,071	6,672	2,891	2,250	10,962	8,922

1. 1970 and 1988 area of comparison is shown hatched on the adjacent map. 1988 data from New FIP File 93 P block. 1970 data for two blocks shown (i.e. A upper, P lower). Based on Area/Volume summaries provided by Forgis Consultants Ltd., Victoria, B.C.

APPENDIX 2 - Agricultural and Aspen Production Models and Cash Flow Analyses

COMMENTS, ASSUMPTIONS AND SOURCES FOR AGRICULTURE COMPARISONS

At present there is no data source to compare agricultural productivity or forest productivity to land classifications. Averages which include all land classes are available for some agriculture products.

Canada Land Inventory Class 4 land may be above regional averages in hay or pasture productivity. Moisture is the biggest limiting factor for hay production. Climate (specifically frost free period) or soil properties such as stone content may result in a low CLI classification for production of grain without affecting potential to produce hay crops.

In many cases, management makes a greater difference in yield then inherent capability of the land.

Rental rates cannot be related very well to land quality, or yield and quality of agricultural production. Based on interviews and experience of local producers, prices for land rental are extremely variable. Factors included are land quality, distance between rented land and the renters home (some premium may be paid for proximity), distance to major centres (more alternatives in land use and potential renters closer to a major centre), weed problems on the land, and potential prices for products from the rented land.

Particularly in areas where land quality is poorer (dominantly Class 4 or 5), most farming operations are a mix of grain, hay, and livestock production. Production of grasses and legumes for seed is important in the Peace River area and potentially gives a high return on lower capability land. This type of production has not been well documented.

The Crop Insurance averages available do not reflect the top 30% of agricultural producers. On poorer quality land, these producers put in greater quantities of inputs to compensate for lower inherent fertility.

Off-farm income is the norm in the Peace River area. The great majority of farms would have off-farm income from, for example, the oil industry, trucking, or jobs in town. Rural lifestyle, and belief that farm improvements will eventually be capitalized when the farm is sold at retirement, lead to subsidizing farm operations with other income.

Pasture rental is not very common for cattle. Animal Unit Months (AUM) per acre for good native range are .19 to .21, tame pasture 1.5 to 3.3 (Alta. Agric. 1980). In B.C. cattle producers can graze on Crown Land (Community pasture, Grazing leases) for $8/AUM.

For 1989 and probably 1990, grain farming is unlikely to give a proper return to investment for most grain producers in the B.C. Peace River area. This is reflected in the large amounts of land for sale at present. People survive by foregoing a true return for their labour and investment and by holding off-farm jobs.

COST AND PRICE ASSUMPTIONS

1. Average farm inputs Peace River Area at 1989 costs and prices.
2. High crop insurance at $14.08 per ha and low at $7.04 per ha.
3. Owner labour and management at $15.00 per seeded acre and hired labour at $12.00 per acre
4. Working capital cost at 13% per annum or 6.5% for 6 months.
5. Farm taxes at $1.00 per acre per year.
7. Farm equipment at $371.00 per ha. Depreciation 12% straight line.
8. Buildings valued at $74.00 per ha. Depreciation 5% straight line.
9. Pasture rental for "close in" area in South Peace River. Rent $15.00 per acre or $37.00 per ha.
10. In the Pasture Rental Case, fencing at $2,000 per mile and dugouts for water at one per 65 ha at $700 each.
11. Other Yields and prices per ha as shown in each case study.

OTHER ASSUMPTIONS (similar to Hadland 1988)

1. CLI class 4 and 5 land
2. Land value of $247/ha ($100/acre)
3. Farm located more than 30 km (20 miles) from a major centre
4. 400 ha cultivated land
5. All land debt free

SOURCES OF INFORMATION

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Personal discussions with B.C. Ministry of Agriculture and Fisheries staff, local producers, farm supply companies, and agriculture extension specialists.

grain2

	WHEAT 3RS	BARLEY 1F	CANOLA 1
AREA/CROP (ha)	133	133	134
VARIABLE/OP COSTS			
seed + treatment	22.24	19.77	17.30
fertilizers NP	50.66	50.66	55.11
herbicides	14.83	14.83	33.63
crop insurance	14.08	14.08	14.08
fuel/lube	28.59	28.59	28.59
machine maintenance	23.47	23.47	23.47
owner labor/mgmt	37.07	37.07	37.07
hired labor	29.65	29.65	29.65
SUBTOTAL	220.59	218.12	238.90
working capital cost 6.5%	14.34	14.18	15.53
VARIABLE/OP COSTS	234.92	232.29	254.42
FIXED COSTS			
land taxes	2.47	2.47	2.47
TOTAL COST TO OWNER	237.39	234.76	256.89
YIELD (tonnes/ha)	2.08	2.04	0.78
CROP PRICE $/tonne	186.78	126.56	245.00
GROSS INCOME/HA	388.50	258.18	191.10
GROSS FARM INCOME	51670.82	34338.26	25607.40
TOTAL FARM		111616.48	
TOTAL OWNER COSTS	31573.27	31223.41	34423.69
TOTAL FARM		97220.37	
AVAILABLE TO SERVICE CAPITAL & OWNER PRFT	20097.55	3114.85	-8816.29
PRE-CAPITAL FARM NET		14396.11	
CAPITAL COSTS			
farm equipment	148000	8 yr life	17761/ann depr
land	98800		
buildings	29600	20 yr life	1480/ann depr

farmflo2

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
						1.50% real increase land value
NPV @	6%	-194935				
YEAR	1	-262004	111616	97220	276400	
	2	14396	111616	97220		
	3	14396	111616	97220		
	4	14396	111616	97220		
	5	14396	111616	97220		
	6	14396	111616	97220		
	7	14396	111616	97220		
	8	-133604	111616	97220	148000	
	9	14396	111616	97220		
	10	14396	111616	97220		
	11	14396	111616	97220		
	12	14396	111616	97220		
	13	14396	111616	97220		
	14	14396	111616	97220		
	15	14396	111616	97220		
	16	-133604	111616	97220	148000	
	17	14396	111616	97220		
	18	14396	111616	97220		
	19	14396	111616	97220		
	20	14396	111616	97220		
	21	14396	111616	97220		
	22	14396	111616	97220		
	23	14396	111616	97220		
	24	14396	111616	97220		
	25	155631	111616	97220	-141235	
0-int cashflo		-71265				

grain3

	WHEAT 3RS	BARLEY 1F	CANOLA 1
AREA/CROP (ha)	133	133	134
VARIABLE/OP COSTS			
seed + treatment	22.24	19.77	17.30
fertilizers NP	72.90	72.90	72.90
herbicides	14.83	14.83	33.63
crop insurance			
fuel/lube	28.59	28.59	28.59
machine maintenance	23.47	23.47	23.47
owner labor/mgmt	37.07	37.07	37.07
hired labor	29.65	29.65	29.65
SUBTOTAL	228.75	226.28	242.61
working capital cost			
6.5%	14.87	14.71	15.77
VARIABLE/OP COSTS	243.61	240.98	258.37
FIXED COSTS			
land taxes	2.47	2.47	2.47
TOTAL COST TO OWNER	246.08	243.45	260.84
YIELD (tonnes/ha)	3.4	4.3	1.6
CROP PRICE $/tonne	186.78	126.56	245.00
GROSS INCOME/HA	635.05	544.21	392.00
GROSS FARM INCOME	84461.92	72379.66	52528.00
TOTAL FARM		209369.58	
TOTAL OWNER COSTS	32729.10	32379.23	34953.14
TOTAL FARM		100061.47	
AVAILABLE TO SERVICE CAPITAL & OWNER PRFT	51732.82	40000.43	17574.86
PRE-CAPITAL FARM NET		109308.11	

CAPITAL COSTS

farm equipment	148000	8 yr life	17761/ann depr
land	98800		
buildings	29600	20 yr life	1480/ann depr
	276400		

farmflo3

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
						1.50% real increase
NPV @	6%	1018372				land value
YEAR	1	-167091	209370	100061	276400	
	2	109309	209370	100061		
	3	109309	209370	100061		
	4	109309	209370	100061		
	5	109309	209370	100061		
	6	109309	209370	100061		
	7	109309	209370	100061		
	8	-38691	209370	100061	148000	
	9	109309	209370	100061		
	10	109309	209370	100061		
	11	109309	209370	100061		
	12	109309	209370	100061		
	13	109309	209370	100061		
	14	109309	209370	100061		
	15	109309	209370	100061		
	16	-38691	209370	100061	148000	
	17	109309	209370	100061		
	18	109309	209370	100061		
	19	109309	209370	100061		
	20	109309	209370	100061		
	21	109309	209370	100061		
	22	109309	209370	100061		
	23	109309	209370	100061		
	24	109309	209370	100061		
	25	250544	209370	100061	-141235	
0-int cashflo		2301560				

grain3a

	WHEAT 3RS	BARLEY 1F	CANOLA 1
AREA/CROP (ha)	133	133	134
VARIABLE/OP COSTS			
seed + treatment	22.24	19.77	17.30
fertilizers NP	72.90	72.90	72.90
herbicides	14.83	14.83	33.63
crop insurance			
fuel/lube	28.59	28.59	28.59
machine maintenance	23.47	23.47	23.47
owner labor/mgmt	37.07	37.07	37.07
hired labor	29.65	29.65	29.65
SUBTOTAL	228.75	226.28	242.61
working capital cost			
6.5%	14.87	14.71	15.77
VARIABLE/OP COSTS	243.61	240.98	258.37
FIXED COSTS			
land taxes	2.47	2.47	2.47
TOTAL COST TO OWNER	246.08	243.45	260.84
YIELD (tonnes/ha)	3.4	4.3	1.6
CROP PRICE $/tonne	117.64	80.68	245.00
GROSS INCOME/HA	399.98	346.92	392.00
GROSS FARM INCOME	53196.81	46140.89	52528.00
TOTAL FARM		151865.70	
TOTAL OWNER COSTS	32729.10	32379.23	34953.14
TOTAL FARM		100061.47	
AVAILABLE TO SERVICE			
CAPITAL & OWNER PRFT	20467.71	13761.66	17574.86
PRE-CAPITAL FARM NET		51804.23	

CAPITAL COSTS

farm equipment	148000	8 yr life	17761/ann depr
land	98800		
buildings	29600	20 yr life	1480/ann depr
	276400		

frmflo3a

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
					1.50%	real increase
NPV @	6%	283278				land value
YEAR	1	-224595	151866	100061	276400	
	2	51805	151866	100061		
	3	51805	151866	100061		
	4	51805	151866	100061		
	5	51805	151866	100061		
	6	51805	151866	100061		
	7	51805	151866	100061		
	8	-96195	151866	100061	148000	
	9	51805	151866	100061		
	10	51805	151866	100061		
	11	51805	151866	100061		
	12	51805	151866	100061		
	13	51805	151866	100061		
	14	51805	151866	100061		
	15	51805	151866	100061		
	16	-96195	151866	100061	148000	
	17	51805	151866	100061		
	18	51805	151866	100061		
	19	51805	151866	100061		
	20	51805	151866	100061		
	21	51805	151866	100061		
	22	51805	151866	100061		
	23	51805	151866	100061		
	24	51805	151866	100061		
	25	193040	151866	100061	-141235	
0-int cashflo		863960				

grain4

	WHEAT 3RS	BARLEY 1F	CANOLA 1
AREA/CROP (ha)	133	133	134
VARIABLE/OP COSTS			
seed + treatment	22.24	19.77	17.30
fertilizers NP	23.25	23.25	35.38
herbicides	14.83	14.83	2.50
crop insurance	7.04	7.04	7.04
fuel/lube	28.59	28.59	28.59
machine maintenance	23.47	23.47	23.47
owner labor/mgmt	37.07	37.07	37.07
hired labor	29.65	29.65	29.65
SUBTOTAL	186.14	183.67	181.00
working capital cost 6.5%	12.10	11.94	11.76
VARIABLE/OP COSTS	198.23	195.60	192.76
FIXED COSTS			
land taxes	2.47	2.47	2.47
TOTAL COST TO OWNER	200.70	198.07	195.23
YIELD (tonnes/ha)	2.08	2.04	0.78
CROP PRICE $/tonne	117.64	80.68	245.00
GROSS INCOME/HA	244.69	164.59	191.10
GROSS FARM INCOME	32543.93	21890.10	25607.40
TOTAL FARM		80041.43	
TOTAL OWNER COSTS	26693.60	26343.74	26160.78
TOTAL FARM		79198.12	
AVAILABLE TO SERVICE CAPITAL & OWNER PRFT	5850.33	-4453.64	-553.38
PRE-CAPITAL FARM NET		843.31	

CAPITAL COSTS

farm equipment	148000	8 yr life	17761/ann depr
land	98800		
buildings	29600	20 yr life	1480/ann depr
	276400		

farmflo4

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
						1.50% real increase
NPV @	6%	-368187				land value
YEAR	1	-275557	80041	79198	276400	
	2	843	80041	79198		
	3	843	80041	79198		
	4	843	80041	79198		
	5	843	80041	79198		
	6	843	80041	79198		
	7	843	80041	79198		
	8	-147157	80041	79198	148000	
	9	843	80041	79198		
	10	843	80041	79198		
	11	843	80041	79198		
	12	843	80041	79198		
	13	843	80041	79198		
	14	843	80041	79198		
	15	843	80041	79198		
	16	-147157	80041	79198	148000	
	17	843	80041	79198		
	18	843	80041	79198		
	19	843	80041	79198		
	20	843	80041	79198		
	21	843	80041	79198		
	22	843	80041	79198		
	23	843	80041	79198		
	24	843	80041	79198		
	25	142078	80041	79198	-141235	
0-int cashflo		-410090				

grain4a

AREA/CROP (ha)	WHEAT 3RS 133	BARLEY 1F 133	CANOLA 1 134
VARIABLE/OP COSTS			
seed + treatment	22.24	19.77	17.30
fertilizers NP	23.25	23.25	35.38
herbicides	14.83	14.83	2.50
crop insurance	7.04	7.04	7.04
fuel/lube	28.59	28.59	28.59
machine maintenance	23.47	23.47	23.47
owner labor/mgmt	37.07	37.07	37.07
hired labor	29.65	29.65	29.65
SUBTOTAL	186.14	183.67	181.00
working capital cost 6.5%	12.10	11.94	11.76
VARIABLE/OP COSTS	198.23	195.60	192.76
FIXED COSTS			
land taxes	2.47	2.47	2.47
TOTAL COST TO OWNER	200.70	198.07	195.23
YIELD (tonnes/ha)	2.08	2.04	0.78
CROP PRICE $/tonne	186.78	126.56	245.00
GROSS INCOME/HA	388.50	258.18	191.10
GROSS FARM INCOME	51670.82	34338.26	25607.40
TOTAL FARM		111616.48	
TOTAL OWNER COSTS	26693.60	26343.74	26160.78
TOTAL FARM		79198.12	
AVAILABLE TO SERVICE CAPITAL & OWNER PRFT	24977.22	7994.52	-553.38
PRE-CAPITAL FARM NET		32418.36	
CAPITAL COSTS			
farm equipment	148000	8 yr life	17761/ann depr
land	98800		
buildings	29600	20 yr life	1480/ann depr
	276400		

frmflo4a

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
					1.50%	real increase land value
NPV @	6%	35447				
YEAR	1	-243982	111616	79198	276400	
	2	32418	111616	79198		
	3	32418	111616	79198		
	4	32418	111616	79198		
	5	32418	111616	79198		
	6	32418	111616	79198		
	7	32418	111616	79198		
	8	-115582	111616	79198	148000	
	9	32418	111616	79198		
	10	32418	111616	79198		
	11	32418	111616	79198		
	12	32418	111616	79198		
	13	32418	111616	79198		
	14	32418	111616	79198		
	15	32418	111616	79198		
	16	-115582	111616	79198	148000	
	17	32418	111616	79198		
	18	32418	111616	79198		
	19	32418	111616	79198		
	20	32418	111616	79198		
	21	32418	111616	79198		
	22	32418	111616	79198		
	23	32418	111616	79198		
	24	32418	111616	79198		
	25	173653	111616	79198	-141235	
0-int cashflo		379285				

aspen FOREST FARM - EVERY FIFTH YEAR - ASPEN HARVEST
CHIPLOGS

HARVEST EACH FIVE YEARS		28.6 hectares
VOLUME PER HECTARE		239 m3/ha
VARIABLE/OP COSTS	per m3	COST EACH HARVEST
rent line skidder	2.25	15364.29
own labor skidding	2.00	13657.14
own labor handfell	1.50	10242.86
own labor bucking	2.00	13657.14
chainsaw costs	0.50	3414.29
rent loader	1.50	10242.86
own labor loading	1.50	10242.86
trucking 30 Km	5.00	34142.86
SUBTOTAL	16.25	110964.29
working capital cost 3.3%	0.53	3606.34
VARIABLE/OP COSTS	16.78	114570.63 each 5 yr
FIXED COSTS (400 Ha for 5 yr)		
formgmt cost		4200.00
land taxes		1500.00
TOTAL FIXED	(1140/yr)	5700.00 per 5 years
YIELD (tonnes/ha)		239
CROP PRICE $/tonne	20.50	20.50
HARVEST INCOME 5 YR		139985.71
GROSS FARM INCOME EACH FIVE YEARS		139985.71 per 5 years
HARVEST COSTS EACH FIVE YEARS		114570.63 per 5 years
NET HARVEST INCOME/5 YRS		25415.09
AVAILABLE TO SERVICE CAPITAL & OWNER INC.		19715.09 per 5 years
PRE-CAPITAL FARM NET EACH FIVE YEARS		19715.09 per 5 years
CAPITAL COSTS		
farm equipment	(chainsaws covered in opcosts)	
land	98800	
buildings		
	98800	

aspenflo

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
NPV @	6%	6738				1.50% real increase land value
YEAR	1	-74525	139986	115711	98800	
	2	-1140		1140		
	3	-1140		1140		
	4	-1140		1140		
	5	24275	139986	115711		
	6	-1140		1140		
	7	-1140		1140		
	8	-1140		1140		
	9	-1140		1140		
	10	24275	139986	115711		
	11	-1140		1140		
	12	-1140		1140		
	13	-1140		1140		
	14	-1140		1140		
	15	24275	139986	115711		
	16	-1140		1140		
	17	-1140		1140		
	18	-1140		1140		
	19	-1140		1140		
	20	24275	139986	115711		
	21	-1140		1140		
	22	-1140		1140		
	23	-1140		1140		
	24	-1140		1140		
	25	165510	139986	115711	-141235	
0-int cashfo		166425				

aspflo2

		CASH FLOW	FARM REVENUE *	FARM COSTS	CAPITAL INPUTS	1.50% real increase land value	
NPV @	6%	158					
YEAR	1	-76573.8	137937	115711	98800		
	2	-1140		1140		m3	$/m3
	3	-1140		1140		6829	20.20
	4	-1140		1140			137937.14
	5	22226.14	137937	115711			
	6	-1140		1140			
	7	-1140		1140			
	8	-1140		1140			
	9	-1140		1140			
	10	22226	137937	115711			
	11	-1140		1140			
	12	-1140		1140			
	13	-1140		1140			
	14	-1140		1140			
	15	22226	137937	115711			
	16	-1140		1140			
	17	-1140		1140			
	18	-1140		1140			
	19	-1140		1140			
	20	22226	137937	115711			
	21	-1140		1140			
	22	-1140		1140			
	23	-1140		1140			
	24	-1140		1140			
	25	163461	137937	115711	-141235		
0-int cashfo		154132					

* delivered price/tonne assumed @ $20.20

aspflo2a

		CASH FLOW	FARM REVENUE *	FARM COSTS	CAPITAL INPUTS	1.50% real increase land value	
NPV @	6%	81142					
YEAR	1	-76574	137937	115711	98800		
	2	-1140		1140		m3	$/m3
	3	-1140		1140		6829	28.00
	4	-1140		1140			191200
	5	22226	137937	115711			
	6	-1140		1140			
	7	-1140		1140			
	8	-1140		1140			
	9	-1140		1140			
	10	75489	191200	115711			
	11	-1140		1140			
	12	-1140		1140			
	13	-1140		1140			
	14	-1140		1140			
	15	75489	191200	115711			
	16	-1140		1140			
	17	-1140		1140			
	18	-1140		1140			
	19	-1140		1140			
	20	75489	191200	115711			
	21	-1140		1140			
	22	-1140		1140			
	23	-1140		1140			
	24	-1140		1140			
	25	216724	191200	115711	-141235		
0-int cashfo		367183					

* delivered price/tonne assumed @ $20.20
years 1 and 5, 28.00 thereafter

aspfair FOREST FARM - EVERY FIFTH YEAR - ASPEN HARVEST
(fair site) CHIPLOGS

HARVEST EACH FIVE YEARS ..... 25.0 hectares
VOLUME PER HECTARE 205 m3/ha

VARIABLE/OP COSTS	per m3	COST EACH HARVEST	
rent line skidder	2.25	11531.25	
own labor skidding	2.00	10250.00	
own labor handfell	1.50	7687.50	
own labor bucking	2.00	10250.00	
chainsaw costs	0.50	2562.50	
rent loader	1.50	7687.50	
own labor loading	1.50	7687.50	
trucking 30 Km	5.00	25625.00	
SUBTOTAL	16.25	83281.25	
working capital cost 3.3%	0.53	2706.64	
VARIABLE/OP COSTS	16.78	85987.89	each 5 yr
FIXED COSTS (400 Ha for 5 yr)			
formgmt cost		4200.00	
land taxes		1500.00	
TOTAL FIXED	(1140/yr)	5700.00	per 5 years
YIELD (tonnes/ha)		205	
CROP PRICE $/tonne	20.50	20.50	
HARVEST INCOME 5 YR		105062.50	
GROSS FARM INCOME EACH FIVE YEARS		105062.50	per 5 years
HARVEST COSTS EACH FIVE YEARS		85987.89	per 5 years
NET HARVEST INCOME/5 YRS		19074.61	
AVAILABLE TO SERVICE CAPITAL & OWNER INC.		13374.61	per 5 years
PRE-CAPITAL FARM NET EACH FIVE YEARS		13374.61	per 5 years

CAPITAL COSTS	
farm equipment	(chainsaws covered in opcosts)
land	98800
buildings	
	98800

aspflofr

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
						1.50% real increase
NPV @	6%	-13621				land value
YEAR	1	-80865	105063	87128	98800	
	2	-1140		1140		
	3	-1140		1140		
	4	-1140		1140		
	5	17935	105063	87128		
	6	-1140		1140		
	7	-1140		1140		
	8	-1140		1140		
	9	-1140		1140		
	10	17935	105063	87128		
	11	-1140		1140		
	12	-1140		1140		
	13	-1140		1140		
	14	-1140		1140		
	15	17935	105063	87128		
	16	-1140		1140		
	17	-1140		1140		
	18	-1140		1140		
	19	-1140		1140		
	20	17935	105063	87128		
	21	-1140		1140		
	22	-1140		1140		
	23	-1140		1140		
	24	-1140		1140		
	25	159170	105063	87128	-141235	
0-int cashfo		128385				

aspflof2

		CASH FLOW	FARM REVENUE *	FARM COSTS	CAPITAL INPUTS	
NPV @	6%	366			1.50%	real increase land value
YEAR	1	-76509.2	109419	87128	98800	
	2	-1140		1140		m3 $/m3
	3	-1140		1140		5125 21.35
	4	-1140		1140		109418.75
	5	22290.75	109419	87128		
	6	-1140		1140		
	7	-1140		1140		
	8	-1140		1140		
	9	-1140		1140		
	10	22291	109419	87128		
	11	-1140		1140		
	12	-1140		1140		
	13	-1140		1140		
	14	-1140		1140		
	15	22291	109419	87128		
	16	-1140		1140		
	17	-1140		1140		
	18	-1140		1140		
	19	-1140		1140		
	20	22291	109419	87128		
	21	-1140		1140		
	22	-1140		1140		
	23	-1140		1140		
	24	-1140		1140		
	25	163526	109419	87128	-141235	
0-int cashfo		154519				

* delivered price/tonne assumed @ $21.35

makehay

ANNUAL PASTURE WITHOUT IMPROVEMENT	HAY
AREA/CROP (ha)	400
VARIABLE/OP COSTS	
cultivate and seed	
fertilizers NP	4.81
swathing/condition	17.29
round baling	27.17
haul and stack	9.88
SUBTOTAL	59.15
working capital cost 6.5%	3.84
VARIABLE/OP COSTS	62.99
FIXED COSTS	
land taxes	2.47
TOTAL COST TO OWNER	65.46
YIELD (tonnes/ha)	3.2
CROP PRICE $/tonne	40.00
GROSS INCOME/HA	128.00
GROSS FARM INCOME TOTAL FARM	51200.00
TOTAL OWNER COSTS TOTAL FARM	26185.90
AVAILABLE TO SERVICE CAPITAL & OWNER PRFT	25014.10
PRE-CAPITAL FARM NET	25014.10
CAPITAL COSTS	
farm equipment	0
land	98800
buildings	0
	98800

PASTURE RENOVATION EVERY SIX YEARS	HAY
AREA/CROP (ha)	400
VARIABLE/OP COSTS	
cultivate and seed	133.43
fertilizers NP	4.81
swathing/condition	17.29
round baling	27.17
haul and stack (all contract)	9.88
SUBTOTAL	192.58
working capital cost 6.5%	12.52
VARIABLE/OP COSTS	205.10
FIXED COSTS	
land taxes	2.47
TOTAL COST TO OWNER	207.57
YIELD (tonnes/ha)	3.2
CROP PRICE $/tonne	40.00
GROSS INCOME/HA	128.00
GROSS FARM INCOME TOTAL FARM	51200.00
TOTAL OWNER COSTS TOTAL FARM	83027.08
AVAILABLE TO SERVICE CAPITAL & OWNER PRFT	-31827.08
PRE-CAPITAL FARM NET	-31827.08
CAPITAL COSTS	
farm equipment	0
land	98800
buildings	0
	98800

hayflow

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS
					1.50% real increase land value
NPV @	6%	96730			
YEAR	1	-130627	51200	83027	98800
	2	25014	51200	26186	
	3	25014	51200	26186	
	4	25014	51200	26186	
	5	25014	51200	26186	
	6	-31827	51200	83027	
	7	25014	51200	26186	
	8	25014	51200	26186	
	9	25014	51200	26186	
	10	25014	51200	26186	
	11	-31827	51200	83027	
	12	25014	51200	26186	
	13	25014	51200	26186	
	14	25014	51200	26186	
	15	25014	51200	26186	
	16	-31827	51200	83027	
	17	25014	51200	26186	
	18	25014	51200	26186	
	19	25014	51200	26186	
	20	25014	51200	26186	
	21	-31827	51200	83027	
	22	25014	51200	26186	
	23	25014	51200	26186	
	24	25014	51200	26186	
	25	166249	51200	26186	-141235
		383579.8			

ANNUAL PASTURE WITHOUT IMPROVEMENT pasture

	PASTURE
AREA/CROP (ha)	400
VARIABLE/OP COSTS	
plow, disc, harrow	
seed and harrow	
maintenance	1.54
SUBTOTAL	1.54
working capital cost	
6.5%	0.10
VARIABLE/OP COSTS	1.64
FIXED COSTS	
land taxes	2.47
TOTAL COST TO OWNER	4.11
YIELD (hectare)	1
HAY RENTAL/HA	37.07
GROSS INCOME/HA	37.07
GROSS FARM INCOME	14826.00
TOTAL FARM	
TOTAL OWNER COSTS	1645.90
TOTAL FARM	
AVAILABLE TO SERVICE	
CAPITAL & OWNER PRFT	13180.10
PRE-CAPITAL FARM NET	13180.10
CAPITAL COSTS	
fences	21560
land	98800
water dugouts	4200
	124560

PASTURE RENOVATION EVERY SIX YEARS pastflow

	PASTURE
AREA/CROP (ha)	400
VARIABLE/OP COSTS	
plow, disc, harrow	105.02
seed and harrow	30.89
maintenance	1.54
SUBTOTAL	137.45
working capital cost	
6.5%	8.93
VARIABLE/OP COSTS	146.38
FIXED COSTS	
land taxes	2.47
TOTAL COST TO OWNER	148.85
YIELD (hectare)	1
HAY RENTAL/HA	37.05
GROSS INCOME/HA	37.05
GROSS FARM INCOME	14820.00
TOTAL FARM	
TOTAL OWNER COSTS	59541.43
TOTAL FARM	
AVAILABLE TO SERVICE	
CAPITAL & OWNER PRFT	-44721.43
PRE-CAPITAL FARM NET	-44721.43
CAPITAL COSTS	
fences	21560
land	98800
water dugouts	4200
	124560

		CASH FLOW	FARM REVENUE	FARM COSTS	CAPITAL INPUTS	
						1.50% real increase land value
NPV @	6%	-60681				
YEAR	1	-169281	14820	59541	124560	
	2	13174	14820	1646		
	3	13174	14820	1646		
	4	13174	14820	1646		
	5	13174	14820	1646		
	6	-44721	14820	59541		
	7	13174	14820	1646		
	8	13174	14820	1646		
	9	13174	14820	1646		
	10	13174	14820	1646		
	11	13174	14820	1646		
	12	-44721	14820	59541		
	13	13174	14820	1646		
	14	13174	14820	1646		
	15	13174	14820	1646		
	16	13174	14820	1646		
	17	13174	14820	1646		
	18	-44721	14820	59541		
	19	13174	14820	1646		
	20	13174	14820	1646		
	21	13174	14820	1646		
	22	13174	14820	1646		
	23	13174	14820	1646		
	24	13174	14820	1646		
	25	154409	14820	1646	-141235	
		114444.8				

APPENDIX 3 - Log Specifications for the Dawson Creek, B.C. Oriented Strandboard Mill

LOUISIANA-PACIFIC PANEL PRODUCTS, LTD.

LOG QUALITY SPECIFICATIONS

SPECIES: Accepted species are aspen Populus tremuloides the most common species, also known as white poplar. Black cottonwood Populus trichocarpa is also known as balm, black poplar. Balsam Poplar Populus balsamifera is the least common species which occurs in the Peace River Area.

Any other species shall be treated as junk if included in wood deliveries.

LENGTH: Logs must be 100 inches or within ± 2 inches. In metric 2.54 m length ± 5 cm.

ROT: Logs must be 50% or greater firm wood by end. A rule of thumb for heart rot shall be that 2/3 of the inside diameter shall equal 1/3 of the outside log diameter. Therefore for 12 inches diameter log; then the maximum heart rot allowed is 8 inches, approximately 50%.

For any tree which has over 50% rot it must be checked (by boring into it with the power saw) every 2 feet (Fig. 1) until 50% or greater firm wood is found. This checking must be done before measuring the next log multiple.

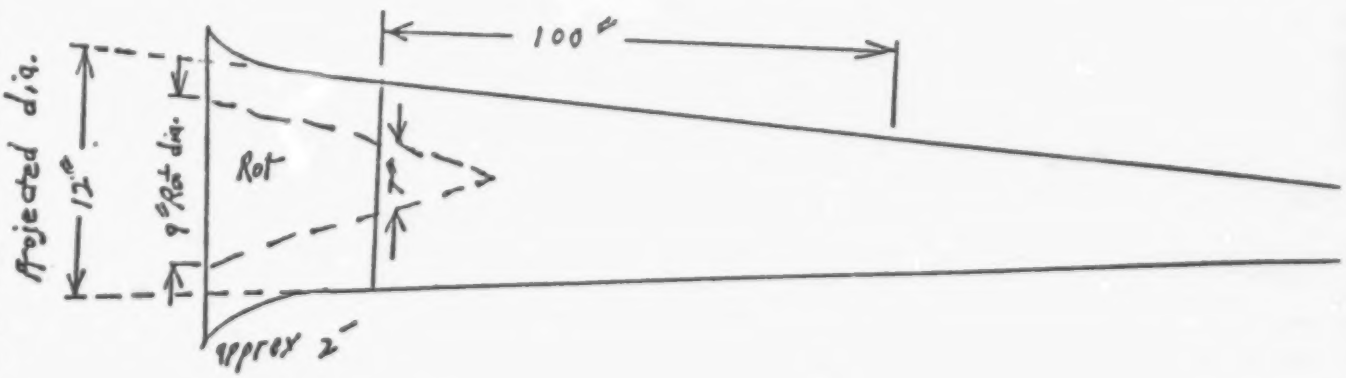


Fig. 1

Figure 1 shows 2 feet of the butt of this tree is waste and must be cut off before the next 100 inch multiple is bucked. Note also the butt flare is not included in the butt diameter. Butt diameter is the diameter of the log which normal log taper has been projected to the butt end. This is not to be confused when determining over size logs. (See OVER SIZE)

Evidence of rot inside a tree may appear as old scars or fungi growing on the tree outside. Fungi may appear from old branch stubs.

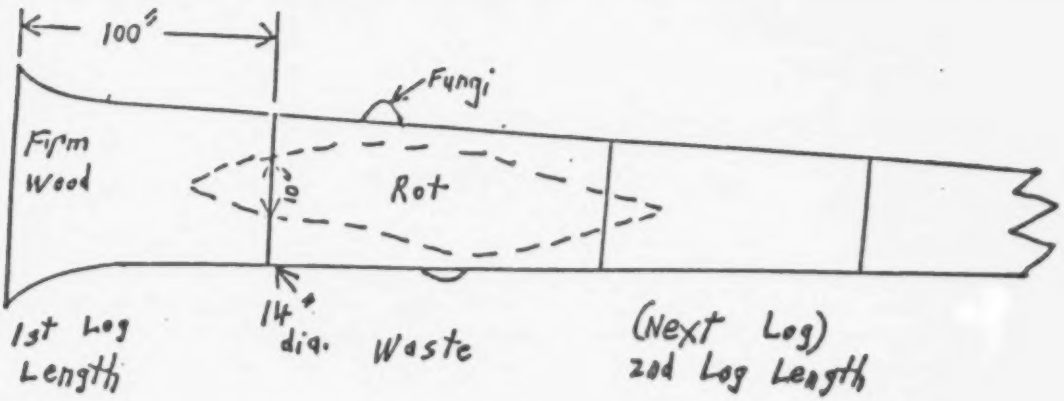


Fig. 2

Figure 2 shows the top end (14 inch diameter) of the 1st log length has rot (10 inch diameter) which exceeds 50% firm wood. It is from the top end of the 1st log length that the tree must be bored (checked) every 2 feet until 50% or greater firm wood is found. The next log length is then measured and bucked.

Rot can easily be determined with a pencil. Firm wood has resistance when a pencil is pressed into it. Therefore rotten wood has weaker fibre and less resistance. This can be achieved with a power saw. Rotten wood has less resistance. Therefore it will cut faster and more easily than firm wood.

Wood may be stained and yet is firm wood.

Rotten wood creates excess fines in our operation, greatly increasing the risk of fires.

BUTT OR TOP ROT: Butt or top rot is determined by end which is over 50% rot. Points charged shall be the portion of log length over 50% rot times the points charged should the piece have over 50% rot for the full length - e.g. a 30 cm diameter log with over 50% for $\frac{1}{4}$ the length would be charged 4 points ($\frac{1}{4}$ x 16).

ROT FULL LENGTH: Is a log which has greater than 50% rot at either end - e.g. a 30 cm diameter log which is greater than 50% rot by end at each end shall be charged 16 points.

BUTT FLARES: Logs with excessive flares will impede our line flow and will jam during the debarking process. These logs are required to have the flare trimmed prior to delivery.

BAD CROOK: Logs must not have more than 6 inch deviation within the log length. Logs with more than one crook are not accepted. Debarking becomes a problem with bad crooks.

FORK: Forks are a problem with handling and at the debarker, they are not accepted.

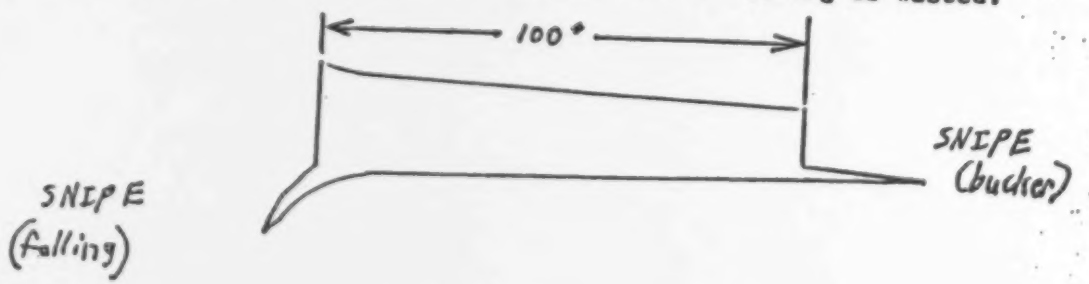
EXCESS LIMBS: Limbs must be cut flush with the bole of the tree. Short stubs shall be considered as limbs.

Limbs are a problem on chain conveyors and at the debarker.

SNIPE: Snipes create truck loading, pond filling and slasher deck difficulty.

A snipe is the piece of wood left attached to the log end. This usually is caused by the bucker not cutting the log entirely through. It may also be from falling.

Each of the logs which we receive shall be slashed into three pieces. As the logs are fed to the slasher deck they are butted against a steel plate. Should a snipe strike the plate first, then the other end of the log is wasted.



DRY WOOD: More fines are produced with dry wood. Dry wood tends to burn the waferized knives due to low natural moisture content.

Under summer conditions logs must arrive at the log yard within three weeks from the time the tree has fallen.

Logs which are deemed to be cut over a three week period shall be treated as dry wood. Dry wood is evident by excessive end checking, brown inner bark, weathered exposed wood, or dry (dead) trees.

JUNK: Junk includes any of the following:

1. Any species which is not accepted. (See Page 2)
2. Sticks, brush, rotten pieces, limbs.
3. Short chunks.
4. Large pieces of foreign material - i.e. ice, dirt, stones.
5. Firm wood which cannot be milled. (split pieces)

OVERSIZE: A log which at any point across the diaganol of the log that is greater than 20 inches at the widest point oytside the bark is an oversize log.

Our debarker will not handle logs over 20 inches (51 cm) diameter. Logs must pass through a debarking ring in the debarking process. The ring has a maximum opening of 20 inches. If a log is too large (over 20 inches) they will jam within the debarker.

UNDER SIZE: Logs must be at least 5 inches (13 cm) inside the bark diameter for 3/4 of the log length. Logs must not decrease under 4 inches (10 cm) diameter in the last ¼ log length. Small diameter logs must be straight and free of rot.

Small diameter logs tend to be broken during the debarking. Also, small logs become crossed in the conveyor enroute to the waferizer.

OVER LENGTH: Logs which are over 102 inches (2.59 m)

UNDER LENGTH: Logs which are under 98 inches (2.49 m). Short pieces cannot be debarked properly and cannot be held firm during the waferizing process.